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CONTENTS.

PAGE

Stone Implements on the Gold Coast. By LINDSAY W. BRISTOWE and H. P. FITZGERALD MARRIOTT, F.R.G.S. (*Illustrated*) 241
Plants and their Food.—VI. By H. H. W. PEARSON, M.A. 244
The Great Telescope of Paris, 1900. By EUGENE ANTONIADI, F.R.A.S. (*Illustrated*) 246
The Great Siderostat of the Paris Telescope. (*Plate.*)
Astronomy without a Telescope. X.—The Meteors of November. By E. WALTER MAUNDER, F.R.A.S. ... 251
Letters:
A NEW FORM OF ACHROMATIC TELESCOPE. By W. B. MUSSON. (*Illustrated*) 252
ARTIFICIAL FACULÆ, SPOTS, AND PHOTOSPHERIC RETICULATION. By ALBERT ALFRED BUSS. Notes by ARTHUR EAST and E. WALTER MAUNDER 252
THE NATURE OF SUNSPOTS. By BARON N. KAULBARS ... 254
WIRELESS TELEGRAPHY AND HERTZIAN WAVES. By S. BOTTONE 254
HIGH-SPEED TELEGRAPHY. By BARON N. KAULBARS. Note by C. H. GARLAND 254
ASTROLOGY. By ALAN LEO. Note by E. WALTER MAUNDER 255
ANCIENT HINDU ASTROLOGY OR ASTRONOMY AND THE NINE PLANETS. By CHARLES G. STUART-MENTEATH. Note by E. WALTER MAUNDER 255
CLAY-STONES. By S. H. WRIGHT. Note by G. A. J. COLE 255
LUNAR RAINBOW. By JOHN MACINTOSH 255
British Ornithological Notes. Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U. 256
Notices of Books 256
BOOKS RECEIVED 259
The Pygmies of the Great Forest. By R. LYDEKKER. (*Illustrated*) 259
Microscopy. By JOHN H. COOKE, F.L.S., F.G.S. 262
Notes on Comets and Meteors. By W. F. DENNING, F.R.A.S. 262
The Face of the Sky for November. By A. FOWLER, F.R.A.S. 263
Chess Column. By C. D. LOCOCK, B.A. 263

STONE IMPLEMENTS ON THE GOLD COAST.

By LINDSAY W. BRISTOWE, *Gold Coast District Commissioner*, and H. P. FITZGERALD MARRIOTT, F.R.G.S.

COMPARATIVELY little is known of pre-historic stone implements from Western Africa. A fresh collection that we have recently gathered presents some interesting points, and induces us to give a general review of the subject, with the native legends concerning these objects. Winwood Reade, to whom the British Museum is indebted for a number of specimens, does not throw much light on them, but says at pages 2-4 in "The Story of the Ashantee Campaign":—"Not only are these stone implements dug up all over the world, but all over the world they are supposed by the common people to be thunder-bolts. As regards Western Africa, this belief is easily explained. The Stone Age is there comparatively recent, and many axes are merely covered by the upper soil. After heavy storms of rain, which are usually accompanied by thunder and lightning, this upper soil being washed away, the stone implements are found lying on the ground, and so seem to have fallen from the sky."

Sir Richard Burton mentions that he was told how Winwood Reade had found fine specimens of hatchets, with holes pierced for hafts, but that neither he nor Captain Cameron had found any on the Gulf of Guinea.

The stone implements that were found at Christiansborg, Akronpong, and Aburi, are now in the Copenhagen Museum, which is unrivalled for its relics of the Stone Age. Some have also been found at Amoaful, and are in Sir John Lubbock's collection, whilst others, found at Akwapim, are in Sir John Evans's collection. The specimens deposited in the British Museum differ both in shape and material from those we have recently procured from Chama and Secondi, on the Gold Coast.

Before describing them, however, we will quote what has been incidentally written on the subject of their presence in West Africa. Winwood Reade says:—"The next time I saw a stone implement was in the tent of Mr. Kühne, at Prahsu. He had found it on an Ashanti altar, or shrine, as he was on his way from Coomassie (Kumassi) to the camp. I asked my interpreter if he had ever seen one before; he replied that they were 'found everywhere,' and I made a small collection during the march through Ashanti. When the troops took a village, I always hunted for this kind of plunder. Sometimes I found the stone hanging before doorways at the end of a string, like a plummet, and often it would be daubed over with chalk. The natives regard these stones with superstitious reverence, and call them god-axes; and believing that all things sacred are medicinal, grind from them a powder which they use for rheumatism and other complaints." We, however, rather doubt whether the stone implements are always daubed with chalk. It certainly is not the case nearer the sea-coast, though it may be in Ashanti, but more probably only on special occasions when the people themselves paint their own bodies white. It is probable that Winwood Reade saw these chalk-daubed stones only on his way down, when the natives were rejoicing at Wolseley's success, for it must be remembered that he was only a hurried passer through as correspondent to *The Times*.

Burton and Cameron describe all the specimens they came across as neolithic—that is to say, of the type produced by grinding. They found none that were palæolithic, or chipped. Arrow-heads and spear-heads are apparently unknown.

A native factotum for one of the local firms at Axim brought Sir Richard Burton some specimens, and told him that "the stones are picked up at the mouth of streams that have washed them down after heavy rains. But the people here, as elsewhere, call them 'Srâman-bo,' or thunder-stones. These Keraunia are supposed to fall with the 'bolt,' to sink into the earth and rise to the surface in the process of years. Hence the people search for them where the 'thunder has fallen.'" "The stones are used as medicine, and those of black colour have generally been boiled in oil to preserve their qualities. After this process they resemble the Basanos (Βάσανος) of Lydian Tmolus. On the Gold Coast, however, the touchstone is mostly a dark jasper imported from Europe." "They are mostly of fine close felsite or the greenstone trap (diorite), found everywhere along the coast. I heard, however, that at

Abusi, beyond Anamabo, and other places further east, specimens of a lightish slaty hue are common. Captain Cameron, whose fine collection is described elsewhere, brought home one that felt and looked like a soapstone coloured *café-au-lait*."

He suggests that Axim was a great centre of stone manufacture, evidently because he observed a number of curiously marked boulders of greenstone, whinstone, ironstone, or diorite. He describes them as having their upper surfaces "scored and striped with leaf-shaped grooves, some of them three feet long by three inches wide and two deep." He thought it probable that chippings of the same rock were here ground to the required size and shape. Of course those geologists who know little of stone implements, Australian stone totems, etc., would naturally at once say on hearing of these grooves, that they had been caused in boulder drift. But we must remember that often the same result may be produced in two or more different ways, and that therefore Burton may be right.

In connection with this, it would be interesting to investigate the large boulder of granite, called Olumo, on the summit of a hill near Abeokuta in the Yoruba country, Lagos; for this boulder is sacred to Oro, and no one may ascend it. Oro means fierceness or tempest, it is also a society, probably manipulated by the Ogboni tribal society in the Yoruba districts. The word is specially applied to the spirit whose voice is heard, the voice being produced, as elsewhere in Africa, Australia, and America, by the bull-roarer, or thin strip of wood, some two and a half inches broad, and a foot long, tapering at both ends, and fastened to a stick by a long string. But since in Australia a similar form has been found in stone as well as in wood, pierced by a hole at one end, and as the latter (of wood) are used as bull-roarers, the resemblance between Australian totems (*churinga* in the Central Australian dialect) and sacred stones in West Africa is striking, and may lead to some further discovery if carefully followed up near Abeokuta. Indeed, as the Olumo stone is sacred to Oro (the voice caused by the bull-roarer), it is possible that stones shaped like bull-roarers may be found to be amongst the secrets kept by the Oro Society, who certainly keep their wooden bull-roarers carefully out of sight of women and the profane. The Olumo may be the rock from which were cut stone bull-roarers, as well as working implements. An examination of its surface would help to decide the *pros* and *cons* of this suggestion.

In "Notes on Yoruba and the Colony and Protectorate of Lagos," a paper read before the Royal Geographical Society by Sir Alfred Moloney, K.C.M.G., there is the following:—"Nor is Yoruba excluded from the widespread belief that stone implements are thunder-bolts. Some rude celts, shaped as axes and chisels, I have collected; they are called ara* okó. The second great Orisá, or subject of worship, intermediate between man and god (olorun) is Sángó, the thunder-god, a name sometimes applied to the stone implements, which are believed to be the bolts of Sángó, who is also named Dzakuta, the stone-thrower. The greatest reverence is extended to these stones, which are used as family fetiches when they are found by ordinary persons." "Dr. John Evans has remarked upon the strong general resemblance between West African stone implements and those found in Greece and Asia Minor. In their practice, when engaged sacrificially, of daubing these stones with blood, palm oil, etc., the West Africans resemble the Indians."

The collection in the writers' possession, which contains twenty-four specimens, are all, with the exception of one, neolithic, and although diligent search was made, no chipped specimens could be procured; as Burton remarks, they are apparently unknown. Man, though very ancient in other tropical† or sub-tropical parts of Africa, in these districts of the West Coast probably appeared at a later period owing to the swampy vegetation, disagreeable climate, and presumable volcanic state of other portions. Moreover, here mankind does not seem to have developed a want for stone implements, whilst in other parts of the world he had long ago passed the palæolithic stage, for all those celts as yet found are highly finished, and there are none there that show a preparatory period of evolution. The perfection of these instruments goes far to prove that they were imported by migrating or conquering races, and that the ancient possessors of the low-lying forest coasts of West Africa, if they ever existed, had never even arrived at a Stone Age of any sort, being content to subsist on what could be obtained by wooden instruments, and on fruit and roots, torn by the hands from their place of growth.

The majority of the twenty-four specimens are of felspathic rock, some light in colour and others dark, whilst real lidites and igneous rock are the materials from which the balance have been made. There is one formed from augitic lava, and another consists of a kind of augite and felspar. The exception already referred to is a touchstone, which has been in use among a family of native jewellers for the past century. It is of black limestone. As will be seen from the photographs of these celts, specimens Nos. 4, 14, 17, and 19, are particularly good in shape and size. No. 21, the darkest and smoothest of the light green (felspathic rock) axe-heads, is like in colour, and probably in material (but not in shape), to some in the Japanese section of stone implements in the British Museum, marked Hakodate. Those axe-heads or wedges in the British Museum, presented by Mr. Andrew Swanzy, and collected by Mr. Winwood Reade at Odumassie, near the Volta, and in the province of Akwapim, Gold Coast, are none as broad at the edge as those of the present collection, only a solitary small one approaching the same shape, but there appear to be none like No. 1 in either form or material.

The Gold Coast is rich in these interesting pre-historic remains. From one extreme of the colony to the other, specimens are to be found, and we venture to think the present collection a valuable addition to those already unearthed. We studied the subject, however, more from an ethnological standpoint than any other.

The similarity of ideas that prevails in the superstitious beliefs of the human race on the subject of neolithic celts is well worthy of study, not so much on account of the main idea that they are thunder-bolts, as for the almost identical beliefs obtaining as to the wonderful properties possessed by these stones. There is universal belief in their being sovereign protectors against lightning. The Norse peasants hung them in

* I rather suspect that this word is the same as *Oro*, for the annual festival of Oro at Ondo, in the Yoruba country, is called Oro Doko, for even natives pronounce identical words very differently.—H. P. FG. M.

† "Appleton's Science Monthly" (London and New York), Nov., 1895, p. 25, etc., of "Primigenial Skeletons, the Flood and the Glacial Period," by H. P. FitzGerald Marriott.

vats to insure good brews; the West African in his drinking water to render it pure and cool; the Indian of Central America does the same thing. Fishermen and hunters, both in the Old and New Worlds, use them to bring good luck. There is the widespread belief that these stones possess extraordinary curative virtues for severe abdominal pains, either in fever or child-birth; for charms against snake-bites they are a specific.

So far, however, as the West African negro is concerned, an interesting question arises. Does he regard these stones as sacred objects, as objects of devotion, and have they a place in their complex religious beliefs?

To attempt to understand the native mind, and obtain a grasp of their fundamental ideas of religion and morality, requires not only years of patient investigation, untainted by racial prejudice, but it involves a sympathetic interest in all his petty disputes and troubles—none the less real and important to him—and the utmost assistance is to be derived by the study of his folk-lore, as elucidating his mode of thought and the motives that actuate his conduct and actions. A depth of hidden meaning lies buried beneath their simple stories, which have been handed down to them from remote antiquity, in some cases, whilst others are of quite recent date, and tend to show that he is, in thought and ideas, still where he was centuries ago.

It is to the anthropologist that we must look to elucidate the conflicting opinions prevalent on this interesting branch of the human race. In his search after truth, he will gratefully accept the aid of the folk-lorist, who, gathering his knowledge from all sources, will discover that thunder-bolts lie scattered through his domain.

The West African, however, is by nature suspicious. He is perpetually haunted by the idea that some deep motive underlies your questions, and until he gets to know and trust you, takes a particular delight in leading you astray. Even Cruikshank, who lived among them for fifteen years, and was much respected, found the subjects of their religious beliefs "beset with difficulties." As a contribution to this study, we have searched the Coast for these implements and carefully collected legends connected with them, some examples of which we give. It is to be noted that all of them, with the exception of the introductory legend, are connected with the celts in our possession, and are numbered accordingly. The legends themselves have not been repeated by "scholars," or the semi-educated natives, but by most respectable chiefs, who spoke in their own language.

The wicked and malignant fairy of the West African negro is the Anansi or spider, hence their Anansi asems, or Anansi stories. He it was who originally brought disaster on the world, by stealing the first thunder-bolt from Oyankapon (the god of the Ashantis and allied tribes). The story is briefly as follows:—"A very good man, but sorely afflicted, went to lay his troubles at the feet of Oyankapon, and Anansi determined to accompany him and learn what he could of the secrets of heaven. Secreting himself in the woolly head of the negro, he listened attentively to the conversation between Oyankapon and the suppliant. Whilst doing so he saw a curious stone lying on the floor of heaven, and with his usual inquisitiveness wanted to know what it was for. In a second he had stolen it and hid it in his wallet, little imagining Oyankapon had seen him. No sooner had they returned to the earth than Oyankapon made a terrible thunderstorm and shot thousands of these stones down from heaven, with the object of killing Anansi for his inquisitiveness in searching into matters that did not concern him. His agility was so great, however, that he was able to dodge the stones as they fell round him, and escaped unhurt, perhaps because he would not part with the thunder-bolt; but many innocent people were killed. Hence it is that the innocent suffer for the misdeeds of others." The African tale invariably carries a moral, and as the people listen, they cry "Oyea" (very true).

Specimen No. 4.—"When I was a young man," said the old chief Ekoom, "I farmed this hill on which the Commissioner's bungalow now stands. One day, after a very bad thunderstorm, I went to my farm, and to

Stone Implements from West Africa.

my surprise saw that a very old tree, which stood in the centre of my farm, had been struck by a thunder-bolt, and was all burnt and charred. This was a bad sign, Oyankapon had killed the tree with his stone from heaven, as a sign that I should work there no more; but, as I looked at the tree, I saw embedded in it the stone, and my heart felt good, for I knew that good luck always attends the person who finds a thunder-bolt. And so it proved, my farm became wonderfully productive and I prospered."

Specimen No. 8.—"If you tie a piece of thread round

this stone," said the aged chief Dontoh (affectionately called by his people Pappa Dontoh), "and place it in a bowl of boiling water, it will foretell, in a wonderful manner, whether a woman in travail will be safely delivered or not. If not, the thread will become loosened and slip off the stone, if she will, it will remain intact." Whether this property was inherent in all thunder-bolts he seemed doubtful. Each had its own peculiarities. He smiled at the suggestion that these thunder-bolts were the work of man. "Did I not see it fall with my own eyes from heaven?"

Specimen No. 24.—"It is not for me to inquire into the ways of Oyankapon," said the chief of Tacorady, "but anyone who says that these stones do not possess wonderful power is a fool. Now look at this one. I found it and I know what it is good for. When I was a young man I used to be a hunter. One day, when I had been very unsuccessful, and was resting under a tree, a heavy thunderstorm came on, and I saw the fire (lightning) strike the ground and dig it up. I went and searched the place and found this stone. After the rain was over I continued searching after game, and shot many. Ever since, when I have taken out this stone in my shot-bag, I have been successful. Now does this not clearly prove that this stone's particular virtue lies in discovering game."

Specimen No. 18.—"My daughter is a grown woman now," said chief Etrue, "but when she was a little girl this stone saved her life. She accompanied her mother who had gone into the Denkera country to sell cloths. Before entering the principal town she discovered a thunder-bolt lying on the ground, and picked it up, as a child always does, to make a plaything of. Her mother was murdered in that country, but the child escaped in a miraculous manner to tell the tale."

Specimen No. 14.—"This stone has been in my family for a long time, and has cured us of many complaints," said another chief. "Once my little son was suffering from weakness, and our native doctors could do nothing for him. Then an old woman told us to soak the stone in water, and make the child drink the water. In no time the little fellow regained his strength."

From a very brief account here given of the superstitions attached to these stones, one would be led to believe that the West African regards them as "fetich," as objects of reverential awe—the conclusion Sir Alfred Moloney came to—but such is not the case. Anyone who has lived among the negroes of Central America and the West Indies (who are the descendants of slaves exported from West Africa), know the ideas prevalent on the subject, viz., that they are lucky objects and nothing more. In exactly similar a manner are they regarded by West Africans.

As a curious illustration relative to the subject, we find that the name of the tutelary god of a large section of the Gold Coast people, Busum, is applied to any small object that takes their fancy, such as a particular shaped cowrie, a pebble, a bean. This is carried about by the individual, for luck, and in gambling he will say, laying down his Busum before him, "Now I am bound to win for there is my Busum." In the island of Jamaica, the descendants of these same people have corrupted the word into Buzo, and the Central American negroes into Guzo. Now here is the name of their sacred god, the god whose name they invoke when taking a solemn oath, used for the idle purpose of a charm. On investigation it will be found that, at all events amongst the Gold Coast natives, thunder-bolts are similarly regarded as lucky objects, and nothing more. This may be considered a fine distinction, but it is the neglect to study these apparently unimportant differences that so often causes us to run away with absolutely wrong ideas of native thought and feeling; complex and involved as it is, we only make the task more difficult.

In conclusion, we will quote the words of an aged chief, which conveys in no doubtful language the position thunder-bolts play in their religious beliefs. He was asked to explain why, if they believed these stones contained miraculous properties, they parted with them. "You may appreciate a thing very highly, yet, when your friend asks it of you, you freely give it, with luck you can get another. But, who in his senses would part with his Souman (the household deity of the individual)? The former anyone, with luck, can procure; the latter, never."

PLANTS AND THEIR FOOD.—VI.

By H. H. W. PEARSON, M.A.

THE remarkable association for mutual benefit which exists between the root-organisms of leguminous plants and the hosts whose roots they inhabit is not the only one of the kind which must be noticed in connection with the food-supply. As was pointed out in the preceding article, our knowledge of the benefits accruing to either member of the firm as a result of this partnership is incomplete. This is also true of another association between fungi and the roots of flowering plants, which in this case do not belong to the family Leguminosæ.

Many plants, including a large number of Orchids, the Heaths which constitute the larger mass of the plant-population of our moors, as well as many familiar British trees, possess few root-hairs or none at all, their place being supplied by the fine thread-like filaments of the fungus. This so-called "mycorhiza" or "fungus-root" is of two kinds. In many ground orchids and in the members of the Heath family the fungus establishes itself in the external cells of the root whence it sends out into the soil free filaments which serve the purpose of root-hairs. In the Beech and related trees the connection between the fungus and the root is less intimate. Here the filaments do not penetrate the outer cells of the root, but, instead, become closely interwoven forming a mantle over the end of the root, investing it as the finger of a glove invests its occupant. From this mantle proceed numerous filaments which force themselves among the soil-particles after the manner of root-hairs. In most cases little is known of the fungi which enter into such unions with the roots of higher plants. In some, notably in that of the Pine, the mycorhizal filaments belong to the fungus whose fruits are so well known under the name of "truffles." In this association of fungi with the roots of higher plants the benefit is mutual. When the filaments penetrate the living cells of the roots they undoubtedly receive therefrom organic substances which the fungus, being destitute of chlorophyll, is unable to build up for itself.* In return, it to some extent saves its host the necessity of forming root-hairs whose duties are performed by its loose ends. Whether the mycorhiza which simply

* KNOWLEDGE, March, 1900, pp. 55 and 57.

invests the root of its host without penetrating its cells is of similar service is not certain.

The mycorhiza is found especially upon roots which grow in soils rich in decaying humus. It is also invariably present in the roots of plants growing in such soil which possess little or no chlorophyll in their stems and leaves, such, *e.g.*, as the ground orchids. It is therefore probable that it is in some way serviceable in supplying its host with such organic substances as are formed during the decay of plant *débris*.† These may be merely conveyed by the fungus in an unaltered condition into the tissues of its host; on the other hand it may be that they undergo within the cells of the fungus such changes as render them more easily absorbed and assimilated by the green plant. It has also been suggested that another, perhaps the chief, duty of the fungus element of the mycorhizal partnership is, in some cases, connected with the supply of suitable compounds of Nitrogen to the more prominent partner. Fungi absorb certain compounds of ammonia —such as are found in the soil—and, by the activity of their protoplasm, build them up into more complex organic compounds. It is at least possible that this may be the nature of the contribution which the fungus makes to the plant in or upon whose roots it lives. But to what extent any or all of these relationships exist between the flowering plant and its mycorhiza can only be determined by future research. At present we must conclude that the true significance of this form of association between green plants and the more lowly organised fungi requires further elucidation; there is, however, no doubt that it is of considerable importance in the economy of nature.

We have now considered the principal sources of the food-supply of green plants and the channels by which it reaches the tissue of the plant where it undergoes chemical alteration into compounds suitable to build up and repair the waste of the vegetable organism. Into the nature of these most interesting changes, as yet but incompletely mastered by scientific investigators, limit of space forbids us to enquire further.

The salient feature of our present topic is the relation between the green plant and its carbon-supply. As we have seen, it is enabled by means of the chlorophyll present in the protoplasm of certain of its cells to obtain all that it needs of that most essential constituent of its food from the Carbon dioxide of the atmosphere. This power is unique, being possessed by no living organisms except such as contain chlorophyll. In the cells of the green plant, as a result of the vital activity of protoplasm in the presence of chlorophyll are produced organic compounds (proteids) containing Carbon and Nitrogen in such a form that they are available as food to organisms—plant and animal—destitute of chlorophyll. Among the lower members of the animal kingdom there are numerous instances of organisms possessing chlorophyll, which therefore subsist partly as plants in that they assimilate Carbon dioxide. As an example may be mentioned the fresh water polype, *Hydra viridis*, familiar to microscopists; in the cells of whose endoderm are found granules of chlorophyll similar to those of the plant-cell. On the other hand, numerous members of the upper classes of the vegetable kingdom have to some extent thrown off their plant nature and have become partly animal in their tastes and habits. Some of them almost entirely, others to a less extent have lost the character which is most pronounced in their nearest allies, and have become destroyers instead of builders up of organic Carbon compounds. These *degraded* members of plant society obtain their supplies of organic Carbon from animals or from other plants, living or dead. Of saprophytes (plants which live upon dead organic matter) we have already said something; it is probable that all plants which flourish in rich humus soils are to some extent saprophytic. It would take us far beyond our prescribed limits to enter here upon a discussion of the interesting features of the life of a vegetable parasite. It must suffice to mention one well-known example—the "Dodder," of which there are three species in Britain; the "Clover Dodder" (*Cuscuta epithymum*, Murr.) is perhaps the best known of these. Its thin wiry leafless stems are destitute of chlorophyll, and are therefore of a dirty yellowish-brown colour. They send short root-like projections into the green juicy stems of the clover from which they derive their entire‡ nutriment. In clover-fields the nearly circular and ever-increasing brown patches caused by the prevalence of this pest over the legitimate crop are, in some seasons, but too familiar. There are degrees of parasitism among plants as elsewhere in the organic world. The Dodder is an example of an advanced type in which the parasite is all but reduced to a condition of absolute dependence. The British Flora contains many plants which rob their fellows of valuable nourishment, but whose parasitism is less pronounced than that of the Dodder.§ Among saprophytic green plants there is a group in which the method of obtaining organic nutriment has led to the development of some of the most remarkable forms in the plant world. There are numerous species of carnivorous plants of which a few are represented in our own Flora. Insects are their chief natural prey; and numerous are the devices for capturing them which plants in the course of evolution have adopted. These may be roughly considered in two divisions.

A large section of the vegetable carnivora are provided with chambers or traps into which the animal is allured, and from which it finds escape impossible. Most interesting examples are seen in two or three species which inhabit the marshes and pools of this country. The Bladderworts (*Utricularia vulgaris* and *U. minor*) are small rootless plants floating freely in stagnant water. The ordinary leaves are much divided into green thread-like segments. In many places instead of leaves are borne pale-green nearly transparent ellipsoid bladders, which vary in different species from $\frac{1}{12}$ to $\frac{1}{4}$ inch in diameter. The entrance to the bladder is closed by a valve opening inwards, and is protected on the outside by a tuft of stiff hairs. Only a very small creature such as can crawl in among the tuft of hairs and, pushing in the valve, can pass through a very small orifice, is able to enter. Once inside there is no escape, for the valve fits close and only opens inwards. The bladders which to minute crustaceans, larvæ of gnats, and other insects, small worms and other inhabitants of stagnant fresh water, possibly suggest refuge, or even food, become chambers of death to those which make trial of them. The prisoner is not killed at once, may even live for as long as six days after its capture; after death the products of its decay are absorbed by the plant by means of short cells somewhat resembling root-hairs which project into the chamber from its walls.

† Knowledge, March, 1900, p. 58.

‡ In the very young condition the Dodder is not parasitic, but quickly perishes if it fails to find a suitable host.

§ Knowledge, March, 1900, p. 58.

There can be no doubt that the small animals thus captured are an important part of the food-supply of the Bladderwort; remains of as many as twenty-four crustaceans have been found in a single bladder at one time. Perhaps the most remarkable of the carnivorous plants which capture their prey in this manner are the pitcher-plants. In some of these the whole leaf assumes the extraordinary pitcher-like form from which the plants get their popular name; in others, as in Nepenthes itself, the pitcher is produced by a metamorphosis of the leaf-stalk, the blade of the leaf being represented only by a small lid which more or less covers the pitcher-mouth. There are about fifty species of these extraordinary plants widely distributed in the warmer regions of the earth. Of these about forty belong to the genus Nepenthes, whose home is in the East Indian Archipelago and the adjacent mainland; there are also a few species in Madagascar and tropical Australia. A splendid collection of living plants is to be seen in the new Nepenthes House at Kew. Other genera are represented in N. America (Sarracenia, Darlingtonia), British Guiana (Heliamphora), and Australia (Cephalotus). The pitchers contain a fluid which in some cases (*e.g.*, Nepenthes) is poured into them from special secreting cells in their walls; in others (*e.g.*, Sarracenia) it is partly if not entirely collected rain-water. They are rendered attractive to insects, in some species, by a honey secretion, and in most by a lurid veining of the sides and top which is distinctly suggestive of animal flesh. An insect once inside is prevented by various devices from escaping, and death by drowning in the fluid contents of the pitcher is therefore its fate. Its remains simply rot in the fluid which is absorbed by the plant, or in the case of some species of Nepenthes their decomposition is hastened by an acid constituent of the fluid produced by the plant itself and secreted into the pitcher. Organic compounds derived from the bodies of the animal prey are thus set free and are absorbed into the plant and constitute an important element of its food-supply.

A second class of insectivorous plants is exemplified by another well-known British plant, the beautiful little Sundew, of which three species inhabit bogs and wet places. These and several others to which we are unable to refer here exhibit movements of various kinds in the capture and "digestion" of their insect prey. In the common Sundew (*Drosera rotundifolia*, Linn.), a small plant with a rosette of leaves growing close to the surface of the ground, the leaves are circular, from $\frac{1}{4}$ inch to $\frac{1}{2}$ inch in diameter and attached to the plant by long stalks. The upper surface of the leaf is thickly beset by curious little tentacles terminating in swollen reddish heads, which secrete a colourless sticky fluid. This fluid, glistening like dew in the sunlight, gives to the plant its popular name. A small insect, attracted doubtless by the appearance of honey, alights upon the leaf and is unable to extricate itself from the sticky exudation. Now occurs a wonderful series of movements.‖ The tentacle or tentacles touched by the insect slowly curve over until the victim is thrust down between them upon the flat surface of the leaf. At the same time all the tentacles in the neighbourhood begin to curve and converge towards the same point. The smothering of the prey is thus complete, and its body is quickly decomposed by the acid secretion poured upon it from the cells of the tentacle heads. Its proteids are thus rendered soluble and are absorbed by the leaf. In the case of Drosera it has been experimentally proved that the plant thrives better when it is able to obtain animal food than under other conditions.¶ These examples of the better known carnivorous plants must suffice. They are so remarkable that it is not unlikely that too much importance may be ascribed to this curious habit. It must be borne in mind that although some plants have adopted these practices they represent but a very small part of the immense group of green plants. This method of obtaining Carbon and Nitrogen from the animal body is an abnormal development which is of comparatively little importance in the plant-world as a whole.

‖ In *Drosophyllum lusitanicum*, Link, a native of the Peninsula and Morocco, the process of capture is the same as that described for Drosera, except that the stalked glands (tentacles) are incapable of movement.

THE GREAT TELESCOPE OF PARIS, 1900.

By Eugene Antoniadi, f.r.a.s.

It was at the initiative of M. François Deloncle, plenipotentiary minister, that a group of amateur astronomers decided upon devising for the Paris Exhibition an instrument of exceptional size, far transcending anything that had been before achieved in that line. With this end in view, it was agreed to give to the object glass a diameter of 49.2 inches, that is 9.2 clear inches more than the Yerkes glass at Williams Bay, Wisconsin, and 13.2 inches more than the Lick refractor. Meantime, in order to check, as far as possible, the defects of spherical and chromatic aberration, it was resolved to give the lens the immense focal length of nearly 200 feet.

To mount such a leviathan on an equatorial foot would practically be an impossibility. For to say nothing of the tremendous weight of the tube, and the consequent instability and flexures to which it would be exposed, the protecting dome ought to have a diameter of at least 210 feet, thus surpassing by 72 the cupola of St. Peter's, in Rome, and by 103 feet the dome of St. Sophia, Constantinople. Owing, moreover, to the apparent diurnal swing of the heavens round the Pole Star, the dome ought, during observation, to be in constant motion, so as to keep its opening constantly in front of the object glass, speeding with a velocity of some 50 feet an hour; the eye-piece, too, would have to fly at a comparable

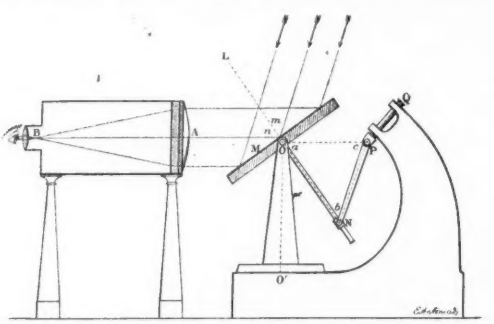

Fig. 1.—Principle of the Siderostat.

pace, and it is needless to point to the inconvenience to which the velocity of such motion would subject the observer.

¶ F. Darwin. *Journal of the Linnean Society*, Vol. XVII., pp. 23 and 599.

In order to surmount these various obstacles it was wisely decided that the mounting be that of the siderostat, such as perfected by Léon Foucault, a man of remarkable mechanical ingenuity. The siderostat is an old invention. During the eighteenth century, Parrault had already constructed a mechanism based on the same principle, while "in 1799," says Lalande,* "an able London optician, named Brown, made a telescope whose tube is always horizontal, and in which a plane mirror reflects the image of the object into the eye-piece."

The siderostat thus consists of a plane mirror, M (Fig. 1), moved by a clockwork motion communicated to the axis PQ, parallel to the axis of the earth, and sending the reflected beam along the optical axis of a fixed telescope, AB.† The mirror is moveable round two axes, a horizontal axis, at right angles to the paper at O, and a vertical axis OO'. At the back and centre of the mirror's cell is fixed a rod, ON, on which glides a muff, N, held by a fork, PN, attached to the polar axis. The length of the fork, PN, being equal to the distance OP, the triangle NOP is, in all positions of the mirror, isosceles, and $\angle a = \angle b$. But $\angle a = \angle n = \angle m$, the angles of reflection and incidence. Hence $\angle m = \angle b$, and thus the direction of the fork PN is always parallel to the incident ray.

Now, in virtue of the problem of revolving mirrors, the angular velocity of the mirror is one-half that of the celestial sphere. This is obtained by imparting to the axis PQ a double velocity, so as to make it rotate once in 24h. Inasmuch as the centre of rotation of the mirror is at O, and not on the middle of NO, its rotation is twice slower than that of the axis, being effected once in 48h., since an angle at the circumference of a circle is one-half the angle at the centre.

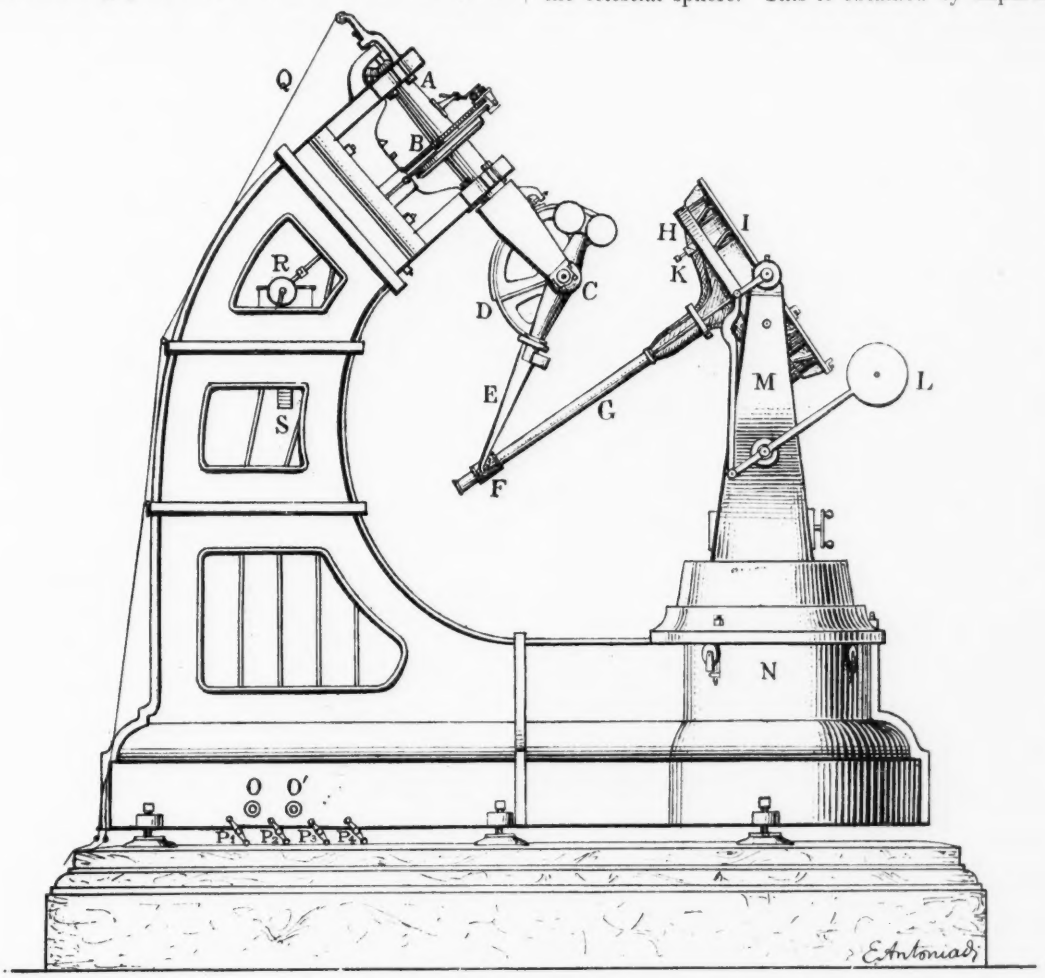

FIG. 2.—The Great Siderostat of Paris, 1900. A, Right ascension axis; B, Right ascension circle; C, Declination axis; D, Declination semi-circle; E, Fork attached to the declination axis; F, Muff held by the fork; G, Brass rod fixed normally to the mirror's cell; H, Cell of the mirror; I, Silver on glass mirror of the siderostat; K, Screw allowing of the mirror being taken out of the cell; L, Counterpoises equilibrating the mirror; M, Great forked support of the mirror; N, Cylinder containing mercury, enabling the floating of the mass M; O, Telescope for reading the divisions of the right ascension circle; O', Telescope for the declination circle; P_1, Handle for slow horary movements; P_2, Handle for rapid movements in right ascension; P_3, Handle for motion in declination; P_4, Handle for winding the clock; Q, Strings for clamping and unclamping in right ascension; R, Clockwork motion; S, Weight of the clock.

* Quoted by Delaunay, *Cours Elémentaire d'Astronomie*, 7e éd., p. 174.

† For clearness's sake, the refractor has been monstrously shortened on the above diagram.

The Paris siderostat is shown on Fig. 2, which was specially drawn for the readers of KNOWLEDGE. Its total length is 27 feet and such is its height also. It weighs, moreover, some 45 tons. The glass mirror itself, whose diameter measures $78\frac{3}{4}$ inches, or more than $6\frac{1}{2}$ feet, and whose thickness is 11 inches, weighs $3\frac{3}{4}$ tons. It is held in equilibrium by a system of levers and counterpoises, and rolls in a cylindrical well containing 22 gallons of mercury. The volume of the submerged part was so calculated that the weight borne by the mercury is nine-tenths of the joint weight of the mirror and its support, that is, nearly 13 tons.

This description of the mechanism will be rendered clearer by an inspection of Figs. 3 and 4, showing the axes, circles, forks, and mirror of the siderostat, while the Plate gives a general frontal view of the instrument.

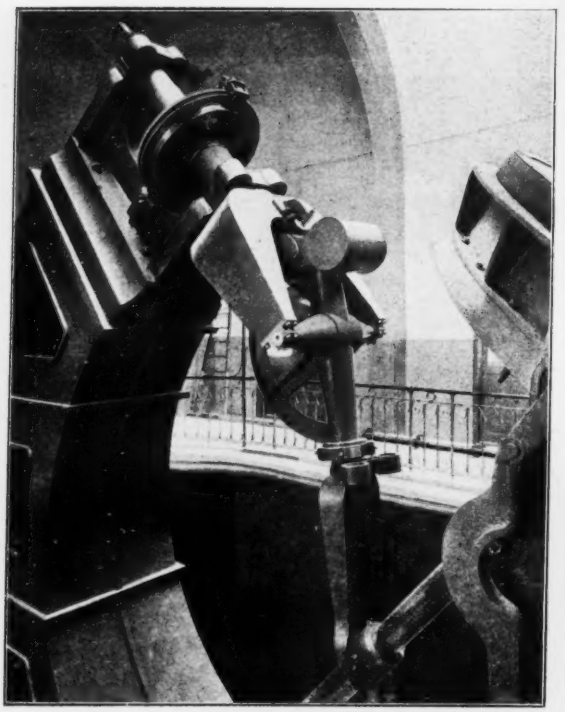

FIG. 3.—Right Ascension and Declination Axes and Circles of the Great Siderostat.

The mirror was cast by M. Despret, in June, 1895, at the glass works of Jeumont. The object glass was cast by M. Mantois, while all the mechanical part of the apparatus, including the figuring of the optical surfaces, was made by M. P. Gautier, optician to the Paris Observatory, whose plans were carried out thoroughly by M. G. Allix, a workman of great skill.

It was no easy task to polish the surfaces of the colossal mirror and of the lenses of the object glass. For this, M. Gautier had to devise a new method. The grinding action of two flat metallic sliders gave to the mirror its flat surface, while the same process was used in figuring the object glass; owing, however, to the slight curves to be given to the surfaces, the slides, instead of being straight, presented the curvature of the disks. The rectilinear motion of the system thus developed gave rise to a cylindrical section, which, however, in virtue of the rotation of the lenses round their axes was transformed into a spherical surface.

In testing the mirror, M. Gautier followed Foucault's process, which consists in examining telescopically the

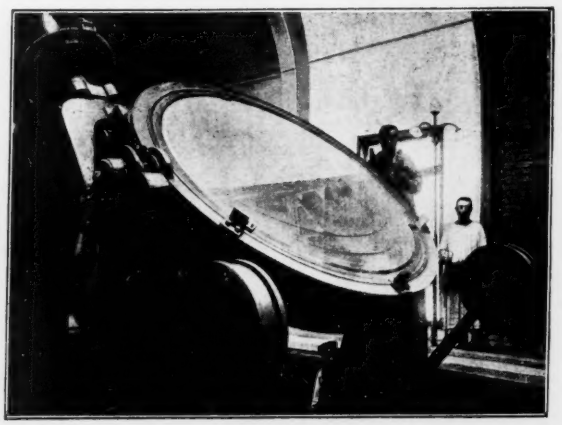

FIG. 4.—The Great Mirror, 79 inches across.
(*Photographed by* M. G. MATHIEU.)

image of a point of light reflected from the mirror. If the surface be quite plane the image reduces itself to a small luminous circle surrounded by concentric diffraction rings. If the portion of the surface under scrutiny is slightly concave, there will be a flattening of the image in the vertical direction, when pushing the eye-piece in, and it will be elongated in the same direction when drawing the eye-piece out. Should the surface be slightly convex, the reverse would take place.

While making these experiments, M. Gautier noticed that the mirror's sensibility was such that by merely

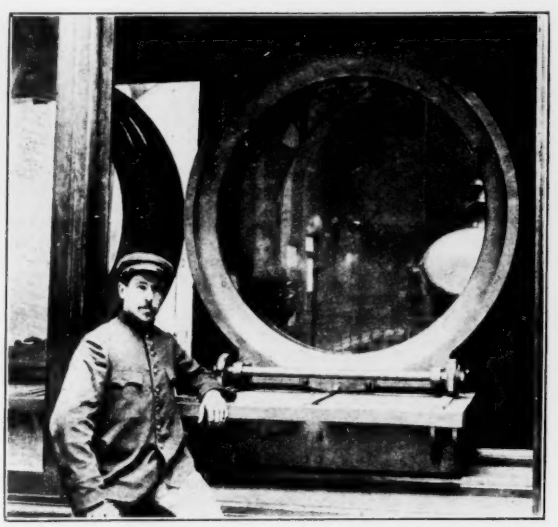

FIG. 5.—The Object Glass of 49·2 inches.
(*Photographed by* M. G. MATHIEU.)

touching the surface with the hand he produced a protuberance deforming the telescopic image at that point, and which, measured with the spherometer, attained $\frac{1}{75000}$ of an inch. The spherometer, meantime, enabled the detection of irregularities in the plane surface, not exceeding $\frac{1}{250000}$ of an inch.

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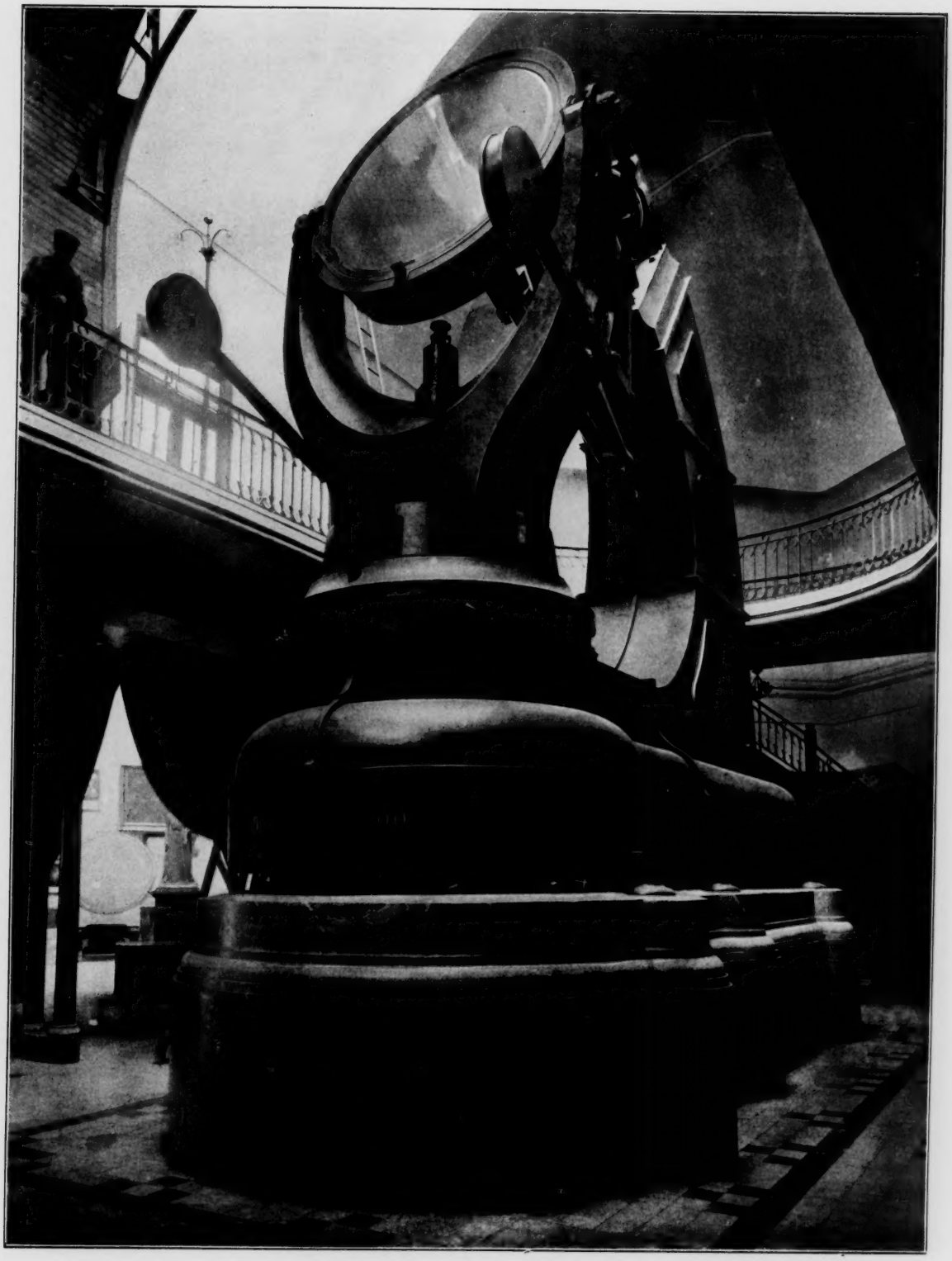

THE GREAT SIDEROSTAT OF THE PARIS TELESCOPE.

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The cylindricity of the axes and rollers of the siderostat was verified with an accuracy of $\frac{1}{250000}$ of an inch.

The diameter of the object glass, which is a photographic one, measures, as above stated, 49.2 inches, and its weight is 794 lbs. But the clear aperture is 47.2 inches, and the focal length some 187 feet. Hence the photographic images of the sun or moon in the primary focus measure from 21 to 22 inches across.

The tube of the telescope is 180 feet long, and 59 inches broad. It is of steel, rather less than $\frac{1}{10}$ inch thick, and weighs 21 tons. The total weight of the instrument, including the siderostat, thus falls but little short of 70 tons. The tube rests on five cast iron supports, besides the two other supports, one at each end.

A short tube, of the same breadth as that of the telescope, but resting on four wheels, forms the eye end. The wheels can glide along a railway, so as to facilitate the focussing of the plate or eyepiece, which would otherwise be extremely inconvenient, seeing that the weight of this eye end is also counted in tons.

Fig. 6 gives a general view of the telescope with the eye end, as mounted in the Palais de l'Optique, Champ de Mars, at the Exhibition.

All heavenly bodies have to be found by their right ascension and declination. There is no possibility of directing the mirror's motion from the eye end. Hence the helpless observer at the eyepiece is to some extent "at the mercy" of the astronomer in charge of the movements of the siderostat, 250 feet off, with whom, however, he can communicate telephonically.

Compared to the Yerkes telescope, the light-grasping power of the Paris refractor is as about $2\frac{2}{3}$ is to 2, in favour of Paris, due allowance being made for the loss of light (8 per cent.) by reflection on the silvered mirror. The stellar penetration of the siderostat ought, therefore, to reach the 18th magnitude.

It was through M. Flammarion's kindness that the writer was enabled to utilize the Paris siderostat.

The planets Jupiter and Saturn were unfortunately out of reach beyond 20° of south declination, inasmuch as it was not thought safe by the maker to allow the mirror to make a smaller angle than 12° with the vertical.

Venus, however, was well situated during the summer, and the writer was enabled to secure a considerable number of drawings of her at daytime. The great telescope showed the planet utterly destitute of detail (Fig. 7).‡ Its appearance was that of a pale yellow crescent or half-moon, with a brighter limb, projected on the dark azure of the sky. Hence the inanity of all rotation periods based on the observation of subjective spots, and fixed sometimes (as in the case of M. Brenner) with the accuracy of one ten-thousandth of a second!

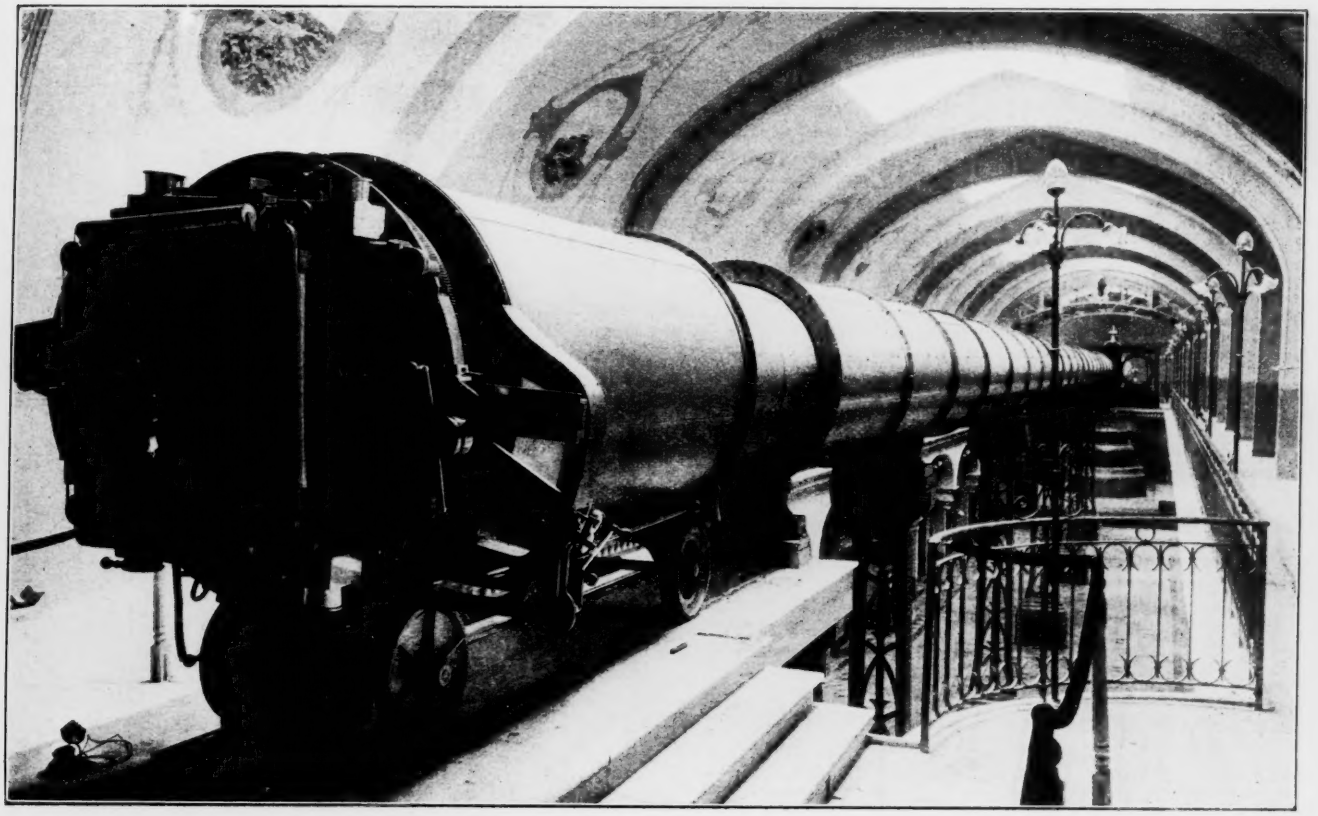


FIG. 6.—General View, showing the eye-end, of the Great Telescope, as mounted in the Palais de l'Optique at the Paris Exhibition.

‡ It will be noticed that owing to the mirror's reflection, the images are inverted east and west. The focus, moreover, for Venus in the great refractor was some ten or fifteen inches farther out than that of stars or nebulæ.

The great light-grasping power of the Paris refractor next proved, as was naturally to be anticipated, wonderfully efficient on nebulæ. Though these delicate objects

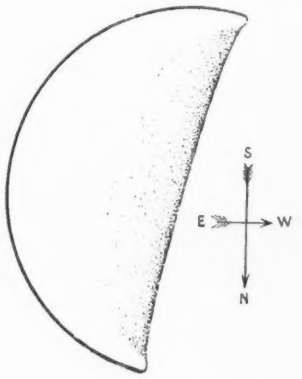


FIG. 7.—The Planet Venus, as seen in the Great Siderostat on 1900, September, 15d. 11h. 40m. G.C.M.T.

require, in order to be advantageously scrutinized, (*a*) a minimum of luminous absorption on the part of the refracting medium, (*b*) a maximum of darkness of the sky, and (*c*) a good definition; and though, on account of the dust, smoke, illumination, and perpetual mixture of air masses of different densities, none of these con

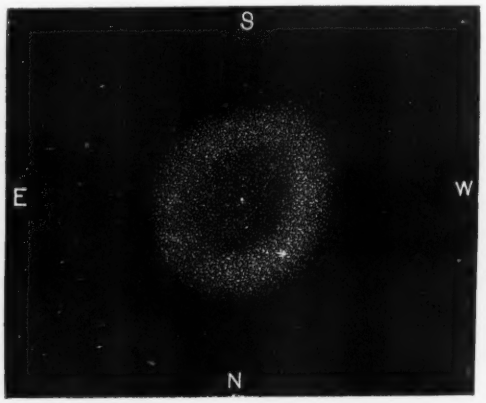


FIG. 8.—Annular Nebula ♄ IV. 13 Cygni, 1900, July 17.

ditions was fulfilled at the Exhibition, the results already secured in this line are very satisfactory indeed.

Thus in the annular nebula ♄ IV. 13 Cygni the siderostat showed, probably for the first time *visually*, the faint central condensation visible on Dr. Isaac Roberts' beautiful negatives, and which is not shown on the drawing published by Lord Rosse II. in his "Observations of Nebulæ and Clusters of Stars made with the 6 foot and 3 foot Reflectors at Birr Castle, from 1848 to 1878," Part III., Plate V. The annulus is, moreover, distinctly elliptical from north-east to south-west, and not round as has been shown heretofore. A faint haziness fills the interior of the ring (Fig. 8).

The spiral structure of ♄ IV. 16 Sagittæ was easily detected with the siderostat, though it was rather hard to say whether the object was a right or left-handed spiral (Fig. 9).

No less interesting was the appearance of the Saturn-like planetary nebula ♄ IV. 1 Aquarii (Fig. 10). In a paper read before the Royal Society on June 20, 1850, Lord Rosse I. described this object thus:—"It has ansæ, which probably indicate a surrounding nebulous ring

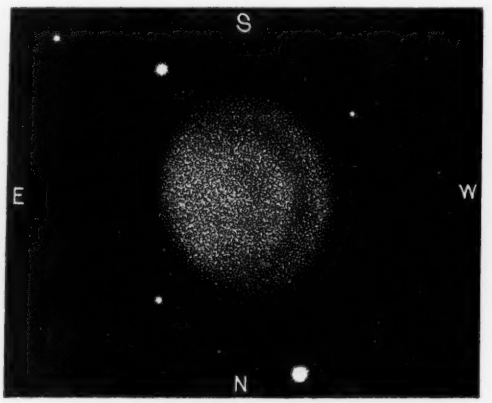


FIG. 9.—Spiral Nebula ♄ IV. 16 Sagittæ, 1900, July 26.

seen edgeways."§ His drawing of ♄ IV. 1 is very remarkable, as showing the nebula in the form of the planet Saturn, flattened at the poles and with a scarcely opened ring—which is also its appearance in the Paris refractor. But the rows of dots shown by Lord Rosse in the body of the nebula, and the rays shooting from it are invisible in the siderostat, and the writer fears that these details are not of an objective character.

We append, in conclusion, a drawing of the central regions of the Andromeda nebula, as seen with the

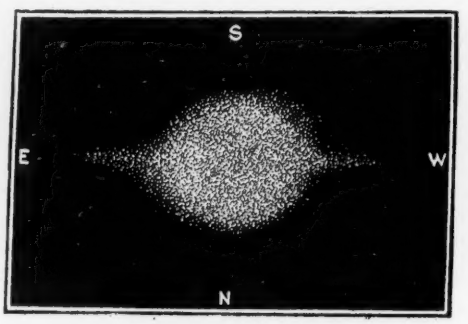


FIG. 10.—Planetary Nebula ♄ IV. 1 Aquarii, 1900, July.

siderostat on September 1 last (Fig. 11), and in which flashed in 1885 the well-known bright temporary star. It will be seen that the nucleus is nebulous at present, and that there is not the slightest indication here of a stellar condensation. It is, moreover, strongly elliptical and not circular, following in this the form of the great nebula itself.

Such are a few of the results obtained with the new siderostat in the midst of Paris in 1900. But it is not in the dust and smoke of great cities that large telescopes show their full power, so that the day when we hear that the huge refractor has been remounted, fully prepared

§ *Philosophical Transactions*, MDCCCL., p. 507.

and equipped, on some well-selected eminence, far from industrial centres, then may we look forward to

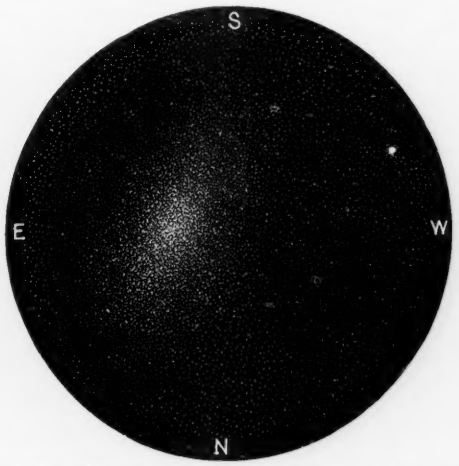


FIG. 11.—The Nucleus of the Great Nebula in Andromeda (M 31), viewed with the Great Telescope on 1900, September 1. (Field of 4′.)

having probably more cogent proofs of its superiority over the telescopes made to the present time.

ASTRONOMY WITHOUT A TELESCOPE.

By E. WALTER MAUNDER, F.R.A.S.

X.—THE METEORS OF NOVEMBER.

THERE can be no doubt as to the appropriate subject to which to call the attention of the "astronomer without a telescope" in this present month. Two great periodical meteor showers come to their node at this time, and all the circumstances of the case should combine to attract the attention of the observer. The possibility that we may have a display which by its mere magnificence would most fully reward the watcher, will perhaps be the point which appeals to the greatest number. A far higher claim is to be found in the number of important questions connected with the two showers, and especially with that of the Leonids, which still wait further observation for their settlement.

So much has been written the last year or two about the great Leonid shower that there is little need to go much into detail. The history of the shower goes back 1000 years to October 12, 902 A.D., a sufficient number of records being extant between this date and November 11, 1799, to show that the shower came in great force on an average three times in a century, and that the day of the shower was moving slowly onwards in the year. The astonishing display which took place on November 12, 1833, which from the accounts preserved would seem to have been the most impressive astronomical spectacle ever witnessed, proved the birth of meteoric astronomy, and the labours of Prof. Newton and Prof. Adams established the fact that the shower was due to an immense swarm of meteors travelling in an elliptic orbit round the sun in a period of 33¼ years; while Prof. Schiaparelli showed that Tempel's Comet, 1866, I., moved in practically the same path.

The great shower of November 13, 1866, added much to our knowledge, and important but less abundant displays were seen in the two following years. After 1869, conspicuous showers from the radiant in Leo ceased, but trained meteor observers have hardly ever failed to notice a few characteristic meteors from this point of the heavens on November 14, or the nights immediately preceding and following.

As there appeared to be a slight increase in the number of meteors as early as 1896, public expectation of a repetition of the grand spectacles of 1833 and 1866 began to be excited in November, 1898, and the interest was increased the following year. It is matter of history that on neither occasion was there anything to answer expectation; a few Leonids indeed were seen, but nothing which by the utmost stretch of language could be described as a great shower. The reason of the failure is matter rather of conjecture than of knowledge. Dr. Johnstone Stoney and Dr. Downing consider that the orbit of the meteors has been so far perturbed that the main stream now passes clear or nearly clear of the earth's orbit, and that our chance of seeing a fine shower from Leo this year is less even than it was last. Our knowledge, however, of the condition of the meteor stream is so slight that we are scarcely justified in hazarding any prophecy. We have gauged the stream at various intervals in its enormous length, but inasmuch as we have never succeeded in seeing the stream in the open sky, we know nothing of it except from the members of the swarm which we actually encounter. In other words, we know nothing of the stream except of such portions of it as the earth has already destroyed. We have, therefore, no right to give up hope of the return of the shower until the fateful days are come and gone.

Should the Leonids revisit us in force either this year or in 1901, the simplest, and for the inexperienced observer, the most useful observation to make, will be that of counting. Counts may be made in two ways. A watch may be kept for a definite time—five minutes, ten minutes, or a quarter of an hour—and the number of meteors seen in that time noted; or starting from a chosen instant, a watch may be kept till ten, twenty, or thirty meteors have been observed, and then the time taken again. The result of the observation in either case should be given at the rate of so many meteors an hour. The observer will find it well to select a definite portion of the sky for his work, carefully recording the boundaries which he assigns to himself; bright and well known stars should be chosen to mark the limits of the field he is scrutinizing. If three or four observers can work together, the entire sky should be divided between them.

The special object of these counts in the case of a great Leonid shower would be to determine whether the stream still appeared, as on several former occasions, to be divided into three distinct sections, the middle or principal section being separated from those preceding and following by a nearly quiescent interval of about six hours. The counts would suffice to show whether the stream was still divided into the same three sections, or whether it had become still more complex in character, and it would also furnish an index of the relative richness of the different portions.

For those who have some experience in meteoric work the most important duty would be the noting of meteoric paths. This work should be carried on over as long an interval as possible, the object being to get good and sharp determinations of the radiant at successive hours during the night in order that if possible the effect upon the apparent radiant point of the rotation of the earth may be made clear. This work had, however, be best

left to those who have already gained some experience in this branch of observation, the Leonid meteors being amongst the swiftest that we encounter, since they come to meet the earth, their relative velocity being some forty-four miles per second, the sum, that is, of the actual orbital speed of the meteors, twenty-six miles, and of the earth some eighteen miles. The phosphorescent streaks, due no doubt to this swiftness of motion, which they leave behind them in their path, are, however, a great assistance to the beginner.

The moon, which reaches its last quarter in the early morning of the 14th instant, will, therefore, interfere very little with the effect of the Leonid shower should we be favoured with a fine one this year, and it will have passed to conjunction with the sun before the second great shower of the month, the Andromedes, reach their node. They furnish in all respects a great contrast to the Leonids. The Leonid radiant does not rise on November 14 until 10.30 in the evening; the Andromede radiant is up the entire night, being nearly in the zenith when the Leonid radiant is rising. The Leonid meteors are extremely swift; the Andromedes are very slow. The Leonids are distinguished by their green colour, suggesting the presence of magnesium; the Andromedes are rather yellow, as if sodium were their chief constituent.

The history of the Andromedes is as well known as that of the Leonids. Whilst the latter approach the sun as nearly as the earth's orbit at their perihelion, and recede somewhat beyond the orbit of Uranus at aphelion, the Andromedes only recede about half-way between the orbits of Jupiter and Saturn. Their period therefore is one of $6\frac{1}{2}$ years as compared with the $33\frac{1}{2}$ of the Leonids, and the greatest showers that we have had from them in recent years have been in 1872, 1885, and 1892. The shower of November 27, 1872, was one of peculiar interest, inasmuch as it was then clearly recognised that the swarm was moving along the same orbit which had been travelled by the lost comet of Biela, the comet which divided into two portions in December, 1846, and which has never been seen since its return, still in two portions, in 1852.

Whilst the Leonid shower has been falling gradually later and later in the year, so that November 15 is now its date of maximum, the Andromedes, or Bielids as they are indifferently called, have moved from November 27 to November 23. This present year is not one in which we have reason to look for the full force of the Andromede shower, but it may well give good practice to the beginner in meteoric observation. The observer should by all means try to record as many paths as possible, the radiant on former occasions having appeared to be rather an elliptic area than as a definite point.

Letters.

[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

A NEW FORM OF ACHROMATIC TELESCOPE.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—A new and original method of correcting chromatism in the combination of lenses suitable for telescope objectives, etc., and for materially reducing the length of such instruments, has been devised and successfully demonstrated by two of the members of the Toronto Astronomical Society; the Messrs. Collins.

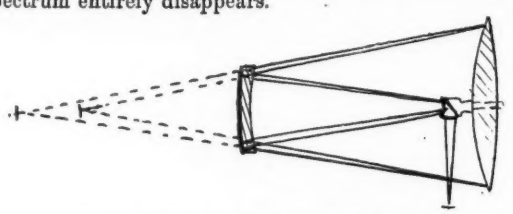
The method consists essentially of interposing a small concavo-convex lens, silvered on the back, in the path of the converging cone of light that has passed through a large single convex object glass, preferably midway down the cone, both lenses being of the same medium of the same refractive index, the small concavo-convex lens having the requisite curvatures to give an equal amount of dispersion in the opposite direction to that produced by the single object glass. After penetrating the correcting lens the otherwise scattered points of light are reflected back from the silvered surface, and brought to a focus at a point slightly in advance of the object glass. A total-reflection prism or a flat intercepts the converging cone before it reaches this point, as in a Newtonian reflector, and throws it to one side, where the image may be examined by an eye-piece, received on a photographic plate, or projected on a screen.

As the positive dispersion of the object glass and the negative dispersion of the corrector are of equal and opposite amount, the dispersive effect entirely disappears and an absolutely achromatic image is formed. Spherical aberration is controlled by the curvatures of the first objective, and the dimension of field by the size of the prism. A total-reflection prism-lens, of the same refractive index as the others, may be substituted for the flat prism, and thereby amplify the focus to any extent that may be required; the curvatures of the small corrector may be changed to correct for the prism-lens, and the latter in turn be made to correct for uniformity of dimensions of all the component colour images, thus delivering to the eye-piece an image focussed entirely on a single plane with component colour images of precisely uniform dimensions on a comparatively wide field.

The shadow of the flat or prism falls on the concave first surface of the corrector, is reflected back, opens out and covers itself, thus preventing reflections from this surface entering the eye-piece to flare the field.

The present field with a	4	in.	objective is	4	in. diameter.
„ „ „	8	„	„	5	„ „
Diameter of prism with a	4	„	„	$\frac{1}{4}$	„ „
„ „ „	8	„	„	1	„ „

Glass of different refractive indexes may be used, but when one kind of glass only is employed, the secondary spectrum entirely disappears.



Collins' Monoplane Achromatic Telescope.

A sketch of the optical part of the experimental instrument that has been made is attached herewith.

W. B. Musson,
Secretary, Toronto Astronomical Society.

ARTIFICIAL FACULÆ, SPOTS, AND PHOTOSPHERIC RETICULATION.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—If in this letter I take the liberty to address you at some length on the above subject, my one plea must be the articles contributed to your valuable journal at various times by the Rev. A. East. These articles involve issues which it is impossible to compress into the ordinary space of a letter.

I cannot help recurring to the foot-note which Mr. Maunder appended to Mr. East's article on artificial sunspots in the December (1897) issue of KNOWLEDGE. Undoubtedly instructive as Mr. East's experiments are, he allows himself to be carried too far in drawing conclusions and pointing to analogies between solar phenomena and a peaceful domestic experiment. It seems to me nothing short of extraordinary on the strength of this latter to even doubt the convertibility of maximum sun-spottedness and maximum solar activity. To be thus, after many years of independent study with telescope and spectroscope, confronted with the proposition that maximum spottedness is synchronous with solar quiescence is upsetting accepted theories with a vengeance.

I have no desire to be flippant, having the subject too seriously at heart, but to come now, in the face of all the information gained as to coincidence of spots, prominences, faculæ, auroræ, and magnetic storms, vivid reversals of spectral lines and distortions, and upset all this because of heating some stuff in a boiling pan, is going too far. Certainly may we believe that solar phenomena are different to their known terrestrial *confrères* in their intensity only, but where are in Mr. East's experiments the stupendous potentials of temperature, pressure, chemical affinities, tremendous velocities, and the host of incidental physical conditions of which we have hardly a proper conception? These solar conditions possibly involving natural laws, which are for ever hidden from human knowledge. But to touch directly on the matter under discussion.

I do not believe for one moment that the actual or visual appearance of the photosphere influences spot formation, but, if anything, that spots about to form influence the appearance of the photosphere locally. Mr. East mentions that *compactness* of the photospheric material favours spot appearance, and yet again says, that the solar poles will never show spots "for there the photospheric matter will always be too closely packed." What are we to make out of such inconsistent arguments? Incidentally I may mention that Mons. Janssen is more reserved as to a different construction of the reticulation of the photosphere in the polar regions as compared with that in the lower latitudes. He says on page 113 of his excellent work:—

"Nous n'avons pu, jusqu'ici, trouver de différences appréciables entre les regions qui, sur ces images, environment le pôle et celles des regions équatoriales."

"Il parait donc, jusqu'ici, que le phénomène de la granulation est un phénomène général à la surface de la photosphère, et qu'il n'est pas en dépendence immediate avec celui des taches."

No doubt, as Mr. East says, the photosphere is torn and churned and dispersed, but by what? I venture to say by spots, and all the other eruptive phenomena connected with them, and that therefore the maximum disturbance of the photosphere is reached practically at the same time as the spot, faculæ, and prominence cycle reaches also its maximum. Certainly the sea may be violently disturbed also after the storm has passed, but still it is not conceivable that the disturbance reaches its maximum much after the storm is at its climax. The passage from solar maximum activity to minimum is a very jerky process, and the present minimum is a strong case in point, inasmuch long after maximum spot activity, that is, *after* the photosphere is so unfavourable to spot formation, we have had spots of extraordinary size and ditto prominences accompanied by auroral displays as late as September, 1898. In short, to my lay mind, it is impossible to imagine that at a time of maximum solar activity I should for consecutive days direct the telespectroscope towards the sun, see no spots and faculæ, and find the edge of the disc as smooth almost as on a turned flywheel.

The argument Mr. East uses to support his view, viz., the coincidence of the spot and prominence maxima, is also open to objection. Mr. East argues that "when the photosphere is diffuse, the solar flames will have but little altitude, when compact all the force is concentrated at the openings of the spots and vast jets of flame are expelled." First let me say that prominences, as a rule, do not issue out of the spot cavity, as this sentence would lead the reader to assume. Furthermore, according to this thesis, one must expect to see the tallest prominences in the polar regions, as there the photosphere is closely packed, as he states elsewhere. My own observations confirm what Prof. Young states, namely, that eruptive prominences appear in the immediate neighbourhood of spots and never near the poles.

When I look over Mr. East's article in general, I must confess I am unable to see what he is desirous to establish or driving at, and his conclusions drawn from his experiments are far from convincing. Again, Mr. East's conception of the origin of prominences, which he illustrates by another experiment, puts a limit to the appearance of these eruptions which is out of all agreement with actual observation. His prominences must all be of one "style" and almost tediously alike, and only different in height at various periods.

There is one point in Mr. East's studies the value of which I set far above his comparisons and conclusions, and that is that he keeps along a line which centres in the assumption *that the causes of solar evolution are to be found on the sun itself*.

As to a satisfactory explanation of the periodicity of spots, etc., no satisfactory solution has come up yet, nor, I venture to say, *ever will*, making respectfully all allowance for future progress of science. We have had the influence of the planets or the periodic return of a large aggregation of meteorites close to the sun as special favourites, but all these propositions carry with them a great deal of doubt and little conviction. As we see the periodicity to be variable to an average extent of two years for *successive* minima and maxima, it is only likely that these two theories will break sadly down. Since to my mind the cause of the cycle is to be found on the sun itself, and is to my conviction contained in the solar contraction and the contending forces set up by it, it is not difficult for me to conceive that successive pulsations cannot be at exact intervals of time, and, as Mr. East says, each successive disturbance is influenced by the greater or lesser intensity of the preceding one. The very magnitude of the sun's proportions seems to imply a rhythm of pulsation appropriate, and if 11.11 years have been found to represent the average of these periods, it is quite reasonable, if perhaps not very scientific, to simply accept this fact. We never seem to trouble our heads much about finding out how it is that the earth takes about 365 days for completing her orbit, or why the sun rotates once in about 25 days, and similar unsolvable problems.

ALBERT ALFRED BUSS.
9, Grosvenor Square, Ashton-on-Mersey.

[May I point out that there is no inconsistency of argument as to the absence of spots at the solar poles,

the contention being that a certain compactness of the photosphere is necessary for the formation of the spots, and that if this condition of the photosphere is wanting, either from *excess* or *defect* of compactness, no spots will form: at the poles, it is suggested, there is excess of compactness. But let me hasten to mollify your correspondent by assuring him that I have no theory of solar physics which I wish to prove by boiling stuff in a pan, he would be a bold man who would venture upon such a course. It is quite the "other way about," and even a peaceful domestic experiment may suggest lines of research, and point to conclusions to be reached by very different methods.—Arthur East.]

[It should be borne in mind that Mr. East's experiments are practically experiments upon the behaviour of convection currents under certain conditions. We have every reason to believe that convection currents play a primary part in the maintenance of the present condition of the sun, and in causing many of the phenomena which we observe upon it. To this extent Mr. East's experiments can teach us a good deal. By watching the behaviour of convection currents on a small scale, at feeble temperatures, and in a simple liquid, we can form a more vivid idea of the behaviour of convection currents on a cosmical scale, at transcendental temperatures, and in gases in which the most diverse elements are mixed or combined together in the most complicated manner. The experiments are most instructive when their necessary limitations are kept in view, nor does it seem to me that Mr. East has forgotten these.

I should like to add my accord with Mr. Buss's assumption, "that the causes of solar evolution are to be found on the sun itself." The eleven-year cycle is, to my view, essentially solar in its causes; not planetary, nor meteoritic. Yet I do think there is evidence of a slight modifying effect of planetary position on sun-spot behaviour; the spots do not, in my opinion, owe their formation to any planetary action; but their growth and decay may be affected to some degree.

[E. Walter Maunder.]

THE NATURE OF SUN-SPOTS.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—With reference to a long series of articles published in Knowledge about different observations of the sun, I wish to draw the attention of your readers to a question concerning the sun which, as far as I remember, has not been recently touched upon, *i.e.*, the nature of solar spots.

This was the subject of a communication which I made last year to our Russian Astronomical Society, in consequence of my having made observations of sun-spots for a series of years.

The observations of the spots show us without any doubt that they are *excavations in the Solar Photosphere*, produced by some yet unknown process. This is probably caused by and consists in enormous gas-eruptions, which after having torn through the photosphere of the sun rise up into the higher parts of its atmosphere and become apparent to us, as protuberances, if projected into the space, on the sun's border, and as faculæ, if projected on the sun's body.

There is certainly not the least doubt that the sun's temperature is rising from its surface to its centre, and that the layers below the photosphere become gradually the hotter the deeper they are placed. This consideration gives us the right to suppose that the sun's deeper layers, which we see through the openings of the spots, must be much hotter than the photosphere, and as such their immense temperature produces vibrations of the ether, of so great a rapidity and such minuteness of wave length that they are out of the range of sensibility of our optic nerves, and are therefore unable to affect our sight. The consequence of this is, that we see them black, because every ether-vibration of a very high range—such as the ultra-violet and the Röntgen-vibrations—are quite inappreciable by our eyes.

If this supposition be proved correct it will be of great value, and will not remain without its influence on our consideration of the whole universe surrounding us, and we shall have the right to put the question: Can we see all the heavenly bodies which surround us, or can there be some of so high temperature that they are black, because quite invisible to our eyes?

Baron N. Kaulbars.

Perki-Törwi, Villa Zewoshko, 5.

WIRELESS TELEGRAPHY AND HERTZIAN WAVES.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—I am extremely pleased and flattered by the kindly critique of my little book, furnished by your reviewer in the September number of Knowledge. Precisely because the reviewer is so generally just I beg to point out that one or two inaccuracies have found a place in the critique, probably owing to hurried reading. In the first place, I say at p. 1, § 2, "Electricity appears to be a vibratory motion in the ultimate molecules of bodies," and not "an electrically charged body consists in rapid vibratory motions," as stated in your review. At p. 3 it is distinctly stated that "conductors offer little resistance to the passage of *electricity*"; but in no part of the book have I stated that non-conductors cannot enter into that vibratory motion which constitutes our electrified condition: on the contrary, at p. 10 it is clearly stated that the insulator lying between the excited body, and the induced, is primarily put into the vibratory state, hence polarised, and capable therefore of setting up a like condition in the surrounding bodies, which if conductors cannot retain this strained condition, hence cannot transmit the inductive effect, unless themselves insulated. S. Bottone.

September 5th, 1900.

HIGH-SPEED TELEGRAPHY.

TO THE EDITORS OF KNOWLEDGE.

Sirs,—No doubt once a paper ribbon is ready the high speed telegraph will work, but nothing is said of how a ribbon with its two rows of perforations is prepared. This operation must, I presume, occupy enormous time, and require a large amount of work.

Baron N. Kaulbars (Lt.-Gen.).

St. Petersburg.

[The perforating of the ribbons is done by a modified Wheatstone perforator, and the speed is the same as the speed of Wheatstone perforating. I have seen men prepare ribbons for the Wheatstone at a speed of 45 to 50 words per minute. If we say 25 words per minute we shall get a speed easily maintained for long periods.

One man can thus prepare 25×60—1500 words per hour. The Pollak-Virág apparatus, described in Knowledge for September, will send more than that number in one minute. So it would require over 60 men to

prepare the ribbons to feed the apparatus. The same number of men would be required to transcribe the work at the receiving end. Thus we have 120 men fully occupied with the work of one wire. Suppose a speech of 6000 words were handed in to a telegraph office. It would under our postal system be cut up into pages of 100 words each. One page would be given to each of the 60 men who would prepare it in 4 minutes. The wire would be occupied not quite 4 minutes in sending it, and the 60 men at the receiving end would transcribe it in 4 minutes. Thus the whole would be received and in writing in less than 12 minutes, or allowing for delays, say in a quarter of an hour. This would be done with only one wire, a result impossible of achievement by any other system.

There is no possibility of getting the whole of the work done automatically, although the latest developments of the system (which have taken place since I wrote my article) promise a step even in that direction. The chief gain is the increased carrying capacity given to the expensive trunk lines, and the great usefulness when a breakdown or other circumstances limit the number of such lines.—C. H. GARLAND.]

ASTROLOGY.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—It is not my intention to enter into an argument concerning the truth, or falsity, of astrology with anyone who refuses to examine the subject for himself, but I wish to point out that I did not suggest that the five sense evidence should be left behind. Astrology is not a physical science, it is essentially meta-physical, and as such, it cannot appeal to the ordinary man of science who has not the intuition, the sixth sense, which is yet to be evolved by the majority.

If Mr. Maunder will change the word paganism into pantheism, he will be right in stating that astrology is a survival of the latter. ALAN LEO,

Editor of *Modern Astrology*.

9, Lyncroft Gardens,
West Hampstead, London, N.W.

[Mr. Chatley writes again at some length, but in view of Mr. Leo's letter, it seems unnecessary to do more than quote from his opening sentence:—"I am desirous of approaching astrology, not as a meta-physical abstraction, but as a material and mathematical science." If astrology were a physical science, there would be good cause for our enquiring into it, though Mr. Chatley is evidently a stranger to the methods and principles of physical research. But when after a history of some thousands of years we find its adherents differing on this fundamental point; the one declaring it is not a physical science but essentially meta-physical, the other, that it is not a meta-physical abstraction but a material and mathematical science, what conclusion can we come to but that it has no real basis at all? At any rate the astrologers must settle its standpoint amongst themselves first. If it be a physical science then we can apply physical and numerical tests to it. If not, it lies outside the scope of KNOWLEDGE, and we must decline further discussion upon it.

Whilst regretting the necessity of thus declining several lengthy communications that have reached us upon the subject, we would desire to acknowledge the courteous tone in which all our correspondents have written.—E. WALTER MAUNDER.]

ANCIENT HINDU ASTROLOGY OR ASTRONOMY AND THE NINE PLANETS.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—The discovery of the planetary nature of Uranus and Neptune has, indeed, not been fortunate for the pretensions of astrology, nor yet for cheiromancy and metoposcopy, it is, however, fair to mention passages from Edward Upham's "History and Doctrine of Budhism . . . with Notices of the Bali or Planetary Incantations," 1829, pp. 87 and 94-5:—"The Birmans mention eight planets, namely the Sun, the Moon, Mercury, Venus, Mars, Jupiter, Saturn, and another named Rahu, *which is invisible*" (italics mine). "The nine planets" in four astronomical works from the country of Dambadewa; expressly calculated for the Bali. Rahu and Kehettu are of the male sex, and *bad planets*. It is true that Upham thinks Rahu was an astrological sign rather than an anticipation of Herschel's discovery.

CHARLES G. STUART-MENTEATH.

23, Upper Bedford Place, W.C.

[*Rahu* was not, strictly speaking, a planet, but was the mysterious body, the "dragon," or "dog," which occasioned an eclipse.—E. WALTER MAUNDER.]

CLAY-STONES.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—In digging a drain for my house, the workmen found three stones in the stiff clay; the largest about a foot in length, about as hard and heavy as iron. They are occasionally found, and are called "clay-stones" by the workmen. They appear to be of the nature of trap rock, and were with difficulty broken, in order to get them out. They were seven feet below the surface. How did they come into the clay? S. H. WRIGHT.

3, Cator Road, Sydenham, S.E.

[I may refer Mr. Wright to Mr. H. Woodward's account of the London Clay, in his "Geology of England and Wales," 2nd edition, p. 436.

These concretions are common in the London clay and often include fossils. They result from the gradual accumulation of calcium carbonate or iron carbonate, or both, about some centre. Similar masses form the famous "black band" ironstones, worked for iron in our shaly coal-measures. The contrast of such nodules with the soft clay from which they have slowly concreted underground is commonly of a striking character.—G. A. J. COLE.]

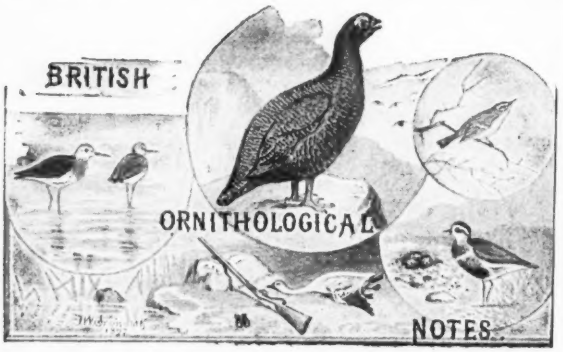
LUNAR RAINBOW.

TO THE EDITORS OF KNOWLEDGE.

SIRS,—A remarkably well-defined *lunar rainbow* was seen here on Wednesday evening, the 3rd of October. It was first observed by the writer about half-past eight, and continued brightly visible till about ten o'clock, when it melted away in the surrounding darkness. The arc seemed from rough calculation to have a diameter about fifteen times that of the moon, and on its upper rim a bright star rested, forming an interesting feature of the phenomenon. From a point near this star a very brilliant blue coloured meteor darted away to the right of the observer in a south-westerly direction. The rainbow was cut off on the lower quadrant by a layer of black clouds. JOHN MACINTOSH.

Strath Cottage, Galston.

XUM



Conducted by HARRY F. WITHERBY, F.Z.S., M.B.O.U.

NUTCRACKER IN LINCOLNSHIRE.—Mr. F. M. Burton describes (see *Naturalist*, October, 1900, pp. 319-20) how he saw and heard a Nutcracker (*Nucifraga caryocatactes*), on August 14th, in a wood near Scotton Common, Lincolnshire. The Nutcracker is of very irregular occurrence in Great Britain. There are several forms of the Nutcracker. One inhabits Scandinavia, West Russia, East Prussia, and the Alps, and another inhabits Asiatic Siberia. It is the Eastern Siberian form that is the chief visitor to Western Europe. This bird periodically wanders westward in autumn, sometimes in large numbers. Such a migration has occurred this autumn in Scandinavia, where, for the last few months the Siberian form of the Nutcracker has been very common. The last "invasion" occurred, I believe, in 1887. The reason for these irregular migrations westward of this bird is considered by good authorities to be the failure in Siberia of the crop of pine-cones, the seeds of which are the Nutcracker's favourite food. Mr. Burton suggests that the bird he saw had bred here in England, but taking the above facts into consideration, this is most unlikely, and Mr. Burton's bird was most probably one of these wanderers from Siberia which are now visiting Norway and Sweden.—H. F. W.

The Greylags of Blair Drummond. By Lt.-Col. Duthie, M.B.O.U. (*Annals of Scottish Nat. Hist.*, October, 1900, pp. 193-6.) Under this title, Col. Duthie gives some interesting particulars of a flock of semi-domesticated Greylag Geese at Blair Drummond, in Perthshire. These birds have originated from a pair brought over from North Uist some twelve years ago. Since then they have reached a maximum of some fifty birds, but are now beginning to decrease. The reason for this seems to be a want of new blood. Although these birds behave much as wild ones, feeding cautiously in the stubbles, sometimes even in the same field as wild birds of their own species, and leaving their home lake in hard weather sometimes for as long as three months, they never associate with the wild birds, and neither go away with them nor bring a stranger back to their "home."

Red-crested Pochard in Yorkshire. (*The Naturalist*, October, 1900, p. 304.) A specimen of this somewhat rare duck is reported by Mr. T. H. Nelson as having been obtained at Redcar on January 20th, 1900. On the same page of the same journal, Mr. J. W. Fawcett reports that a specimen of the Red-crested Pochard was obtained at Redcar on February 10th, 1900. It may be that these two records both refer to the same specimen.

All contributions to the column, either in the way of notes or photographs, should be forwarded to HARRY F. WITHERBY, *at 1, Eliot Place, Blackheath, Kent.*

Notices of Books.

"AN ATLAS OF REPRESENTATIVE STELLAR SPECTRA." By Sir William Huggins, K.C.B., and Lady Huggins. (William Wesley & Son.) An observatory report in an edition de luxe is apt to strike one as something incongruous. And yet, in the book before us, we find the sumptuous form is truly fitted to the results therein expressed. The first volume of the publications of Sir William Huggins' Observatory is certainly unique in its appearance. It is not less so in its contents. It is a beautiful book, and its beauty is but an index of its scientific importance. Its chief purpose as its title implies is to supply an Atlas of Representative Stellar Spectra, so reproduced and arranged as to place the student as nearly as possible in the position of the original observers with respect to the light which those spectra can supply on the subject of Stellar life-history.

As this is the first volume of the publications of the observatory the earlier chapters naturally give an account of the history of the observatory, and descriptions of its instruments, chapter I. being in the main a reproduction of an article appearing in the "Nineteenth Century" for June, 1897. It is an account which, though written with much self-restraint, it is impossible for any scientific reader to peruse without a thrill of intensest interest. It is the story of the first explorer of unknown realms. "The time was indeed one of strained expectation and of scientific exaltation for the astronomer almost without parallel; for nearly every observation revealed a new fact, and nearly every night was red-lettered by some discovery." In all the history of the science there must have been few experiences indeed to parallel those which fell to Sir William Huggins' lot on August 29th, 1864, when he first turned the spectroscope on a planetary nebula, and again on May 18, 1866, when the Nova T Coronæ was first examined.

Chapter II. with its significant initial of the bee-hive with the motto "nil nisi labori" is simply a catalogue of papers published on the work done in the observatory. These are over eighty in number, and almost every one was the breaking up of new ground.

The three following chapters are concerned with the description of observational and instrumental details, and chapter VII. contains a description of Plate II., which is devoted to fifteen "historical Spectra"; some of the most interesting pioneer photographs obtained at the Tulse Hill observatory. The chief importance of the book, however, rests in Plates III. to XII., and chapters VI and VIII., the latter being the detailed description of the plates, with a preliminary discussion of them. Of these Plates XI. and XII. are of quite exceptional importance, containing as they do the separate spectra of the components of six double stars, the beginning of an entirely new subdivision of stellar spectroscopy and one which promises specially important results.

Chapter VI. gives a "discussion of the evolutional order of the stars," and is the principal portion of the text. Next to the great problem of the structure of the heavens, which Sir William Herschel attacked with such Titanic energy, ranks this question of stellar evolution; indeed the two are intimately connected. Ever since the spectroscope enabled us to differentiate between the radiations of star and star it has been under discussion, and especially so within the last decade. Sir William Huggins's treatment of it is characteristic in its clearness, caution, and restraint, and brings out some new points of great importance. Proceeding from the definition that "in a classification of stars, that type of star must come first which we have reason to believe to be the most diffuse, or in other words in the stage in which condensation is least advanced," he insists strongly on the almost forgotten or neglected influence which the change of surface gravitation would exert as condensation proceeded. Adopting Lane's results, Sir William gives great prominence to the fact that the temperature of a star must increase with its condensation, so long as it is purely gaseous. The "youngest," i.e., the least condensed stars, though the richest in potential energy, are therefore not the hottest. In connection with this point he gives the deduction from his own stellar photographs that the "solar" or "metallic" stars,—obviously more condensed than the "hydrogen" or "white" stars—yet have their continuous spectra between the absorption lines relatively more brilliant in the ultra-violet. This is a point of the first importance and is an obvious challenge to the extremely detailed scheme of stellar temperatures recently published by Sir Norman Lockyer. The statement will no doubt be carefully examined by other competent workers, but in the meantime the extreme care, patience and caution which always characterize Sir William and Lady Huggins' work, and the nature of their equipment, enabling them to secure spectra well-defined as far as wave-length 3300, give it a commanding weight.

The quantity of work which Sir William and Lady Huggins have accomplished is remarkable, but its quality is more striking still. Their researches on the spectrum on the great nebula in Andromeda afford perhaps the best illustration of the tireless patience and delicate skill with which they have followed up an object of so much difficulty.

The present volume though so important is evidently not intended by its authors to stand as a complete setting forth of their work. It is Volume I., and all astronomers will look with eager anticipation for Volume II., which we would hope may contain the authors'

researches on the Wolf-Rayet Stars, the study of which they have followed with such conspicuous thoroughness.

"INTRODUCTION TO ZOOLOGY. A Guide to the Study of Animals, for the use of Secondary Schools." By C. B. and G. C. Davenport. (The Macmillan Company.) Illustrated. Price 6s. Unlike many works in popular natural history, in this excellent little volume the greater portion of the text is devoted to the invertebrates, the vertebrates receiving only that amount of space to which they are entitled by "proportionate representation." The contents of the second chapter (taken at haphazard), which treats of the butterfly and its allies, will serve as an example of the method followed in other groups. Firstly, we have the systematic position and characteristics of these insects concisely but adequately explained. This is followed by an account of their habits, which is in turn succeeded by a discourse on the different sexual features and the phenomenon of polymorphism. Next we find a capital dissertation on mimicry and protective resemblances, followed by a brief account of the different families of butterflies and moths. This naturally leads on to the consideration of the other great order of four-winged insects —the Hymenoptera—and the chapter closes with a cleverly drawn-up "key" to the identification of the various families of the two orders in question. Where we have tested these "keys," as we have done in the case of the vertebrates, we find them in the main very satisfactory, although we must protest against the definition "without hands" which is used in the case of the carnivora and rodents, for surely the fore-paws of a squirrel subserve almost all the uses of those appendages. The style in which the work is written is as attractive as the brevity of treatment admits, and we are glad to note that economic zoology comes in for a fair share of attention. Neither are extinct forms altogether omitted, mention being made, as occasion requires, of some of the more important groups. It scarcely, however, gives a true conception of the fact to allude to the various orders of extinct reptiles as if they were merely families of the Lacertilia. All the illustrations are good, and many of them excellent; the reproductions from photographs of living fish by Dr. Shufeldt being a new feature worthy the best attention of all naturalists. The artistic grouping of animals in fac-similes of their natural environment, as in the case of the black Alaskan sheep, is also to be commended. When it is added that laboratory work forms an important item in the contents of this admirable little volume, we think we have said enough to commend it to the best attention of our readers, whether juvenile or otherwise.

"THE LETTERS OF JÖNS JAKOB BERZELIUS AND CHRISTIAN FRIEDRICH SCHÖNBEIN, 1836-1847." Edited by Georg W. A. Kahlbaum. Translated by F. V. Darbishire and N. V. Sidgwick. (Williams and Norgate.) 3s. We have already called attention this year to the letters of Faraday and Schönbein, which were published under the same able editorship as those now before us. Schönbein, as early as 1827, had spoken of Berzelius as one of the leading lights of the age among chemists. He had, indeed, made unsuccessful efforts with London publishers to arrange to translate Berzelius' *Lärbok i Kemien* into English, a disappointment which prevented Schönbein, as he said, not only from benefiting British chemists, but also from raising sufficient money to take him to Stockholm to conclude his studies under "the consummate master of chemical science." In 1828, Schönbein was appointed to his professorship at Bâle, from which place eight years later he began his correspondence with Berzelius. The first of the fourteen letters of Schönbein's included in this volume was despatched from Bâle on the 22nd April, 1836, and contains an account of his experiments on the action of nitric acid on iron; but no answer was received from Berzelius until 4th May, 1837, when he wrote giving his views on the "passive" state of iron, and expressing the hope that the search would be continued. Schönbein's last letter to Stockholm is dated 29th March, 1847, so that intervals of about twelve months elapsed between the different letters. The characteristics to which we directed attention when dealing with the correspondence of the Bâle professor with Faraday are here also very noticeable. Schönbein was always anxious to obtain the opinions of contemporary men of science upon the conclusions he drew from his researches, and ever willing, if he saw sufficient reason, to modify his views. There is, however, an absence of those expressions of cordial friendliness which were so marked and pleasing an accompaniment to the strictly professional interest of the letters which passed between Schönbein and Faraday. But, tracing as they do, the steps which led to the discovery and isolation of ozone, the letters before us are sure to prove of great interest to students of chemistry.

"PAPERS ON MECHANICAL AND PHYSICAL SUBJECTS." By Osborne Reynolds, F.R.S., MEM.INST.C.E., LL.D. Volume I. 1869-1882. (Cambridge University Press.) 15s. net. Professor Reynolds has availed himself of the liberality of the Syndics of the Cambridge University Press, and has had the papers contributed by him to the *Transactions* of various learned societies and other journals reprinted in a collected form. The present volume is the first of two, and contains the work of the years 1869-1882; the remaining part, which is not yet ready, will include papers down to the present year. The chronological order of the essays reveals an interesting peculiarity in the work of most men of science. There is but little continuity in the subjects dealt with year by year. One piece of work sometimes leads to a second of a completely different character, and much time may elapse before the original research is carried forward toward completion. To obviate this difficulty the student consulting the book is provided with two sets of references. When reading earlier papers he is referred forward to succeeding pages on the subject, and in studying later papers there are back references given. It will serve to give some idea of the range of subjects included in Professor Reynolds's researches when it is said that the present volume includes, among many others, papers treating of the tails of comets, the phenomena of thunderstorms, the action of rain to calm the sea, the steering of screw steamers, and the bursting of guns. The steering of ships has been a favourite investigation with Professor Reynolds. Papers 13, 19, 21, 26, 28, 32, and 37 are all concerned with different phases of the all-important question. A second extensive research worked at during these years was that on the dimensional properties of matter in the gaseous state, the account here given of this work runs to 130 large pages. We hope this handsome book will be added to the library of every college where mechanics and physics are taught, and to the reference department of all large libraries. It is but rarely that a professor of engineering makes such valuable additions to scientific knowledge outside his own department as are contained in the papers in the present volume.

"ELECTRIC LIGHTING." By A. C. Swinton. (London: Crosby Lockwood & Son.) 4th Edition. Illustrated. 1s. 6d. That this little book should have attained its fourth edition is to some extent remarkable, for (since it only deals in generalisations concerning the elements of the subject) one might be pardoned for thinking that the public appealed to had been already more than satisfied. However, so far as the work before us goes, it has the very solid merit of being accurate, technically, though there are some passages wherein looseness of expression is to be found. For example, at p. 15, one may read: "A standard candle is the amount of light derived from a candle . . . . etc." Now, clearly, if candles can be derived from the burning of candles, there is very little sense in the burning of any other fuel!! But this, in itself, is a trivial matter, though, unfortunately, such verbal slips meet us more than once. Still, be all this as it may, technically the work is accurate, yet, as already suggested, it does not go far. We find, for instance, "Motor generators" discussed and dismissed in the space of those eight lines which come last! We would suggest both an enlargement and an editor.

"A TEXT-BOOK OF ZOOLOGY, TREATED FROM A BIOLOGICAL STANDPOINT." By Dr. O. Schmeil. Translated by R. Rosentock, and edited by J. T. Cunningham. Parts I. and II. (A. & C. Black.) Illustrated. The dominant idea in this book is the structural adaptation of animals to their inanimate surroundings; and therefore, instead of being a series of dry descriptions of details of anatomy, form, and colouring, it treats of animals as living machines suited to perform particular kinds of work. At least this is stated by the editor to have been the aim of the author; and, on the whole, the intention has been fairly well carried out. The work is intended for schools and colleges; and if young students become imbued

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with its spirit, they will be in a fair way to gain a practical acquaintance with natural history from its best and most attractive side.

Of the two parts before us, the first deals with mammals, while the second is devoted to birds, reptiles (including amphibians), and fishes. A third part will complete the work, which is published at the very low price of 3s. 6d. per part. The mode of treatment is to take a certain number of typical animals, and to draw attention chiefly to those structural peculiarities specially connected with its mode of life; notes on its relatives being added as occasion seems to require.

To an English reader the work suffers to a certain extent from having been "made in Germany." Not only is this apparent in the cast of thought, but frequently in the selection of species as familiar examples which although common on the Continent are unknown in the wild state in Britain. As an example of this treatment from a German point of view, we may quote the concluding sentence from the account of the fox, which runs as follows :— "The sportsman, however, pursues it incessantly, and regards its fur as a small repayment for the many depredations it commits among the game." Surely it was within the province of the editor to excise or modify such a very un-English statement. But, quite apart from certain minor mis-statements of fact, there are points where, in our opinion, editorial supervision is conspicuous by its absence. For example, the author has omitted all mention of such important groups as the Sirenians among mammals, and the Rhynchocephalian lizard among reptiles, while the classification adopted for the birds is hopelessly antiquated and discredited. The illustrations, which are numerous, are by no means of equal merit, a few being excellent, while for others scarcely any words of condemnation are adequate. Being apparently culled from several sources, they do not by any means indicate the relative sizes of the animals depicted; the badger, for example, being drawn of considerably larger size than the Indian rhinoceros. On the whole, while there is undoubtedly much to commend, we think that the publishers would have been better advised had they made arrangements with a competent English naturalist to write an entirely new work.

"ORIGIN AND CHARACTER OF THE BRITISH PEOPLE." By Nottidge C. Macnamara. (Smith, Elder & Co.) 6s. The most casual observer cannot but have been impressed by the pronounced differences in the types of men found in different parts of the British Isles. The characteristic Welshman is manifestly a different kind of man from the average Englishman, and nobody would mistake a native from south-west Ireland for a lowland Scotchman. The object of Mr. Macnamara's little book is to account for these differences, and to trace their causes. He believes that the present peoples of Great Britain are derived from an original Iberian stock, or to use his own words "the Iberians formed the primary stock from which the existing inhabitants of Great Britain, and the West of Europe are derived . . . . . it was this race, and only this race, who inhabited our islands at the close of the palæolithic period." These Iberians were a short, small-boned people, having long skulls and comely features. The next addition to the inhabitants of our islands was from Western Asia, in the early neolithic period, of a branch of the old Aryan race. These tall strangers were an energetic war-like people, who formed the Cro-Magnon race. Then came the dolman-building people. After tracing in this way the origin of the peoples of the British Isles the author takes the constituent countries in succession, beginning with England, and discusses the racial effects of immigrations which have occurred in historical times. He concludes with a consideration of the development of man's intellectual faculties and the effect of residence in cities on the racial qualities of individuals. The book contains thirty-three illustrations, and provides a clear account of a very interesting subject.

"ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM." By S. P. Thompson, F.R.S., etc. (Macmillan.) Illustrated. 4s. 6d. The bibliographical note attached to this work will doubtless exercise much influence, running back as it does to the year 1881, and mentioning no less than three reprints in many of the years which have elapsed since that date. The preface, too, is well worth attention, and we note that Professor Thompson takes an early opportunity of complaining of "The piracy, covert as well as open, to which, since its appearance in 1881, the book has been subjected." In this section of the work we find, too, an accurately terse synopsis of the progress made in matters electrical and magnetic during the past thirty years. The first chapter deals with frictional electricity, and here we are bound to say that we can find nothing new, while many of the illustrations and diagrams are antique. In Chapter 2, Section 154—on magnetic maps—strikes us as being the most useful; while Section 159—magnetic storms—is disappointing. A detailed description of all well-known primary batteries follows. This portion of the book, by the way, contains a statement of Ohm's law, an interpolation which seems quaint. The latter part of Chapter 3, dealing with "Physical and Physiological Effects of the Current," may be highly commended (even to the notice of students of a larger growth, though the book is termed "Elementary"), for it is not, we believe, many who could define such terms as "electric osmose." The collection of notes upon the electrical properties of flame and hot air is interesting, as also those relating to thunderstorms and similar phenomena. On pp. 354-5 we note that the definition of permeability is somewhat lengthy. Indeed, it takes our author some time to explain $M = \frac{B}{H}$ Finally (since this work deals very thoroughly with the elements of electricity and magnetism), it follows that it contains much which has been written again and again. The problems and exercises with which the work concludes are particularly comprehensive, and should be helpful alike to teacher and pupil. The index, too, is good.

"THE STORY OF BIRD-LIFE." By W. P. Pycraft. (Newnes' Library of Useful Stories.) Illustrated. 1s. Mr. Pycraft is to be congratulated in having compressed into the very small compass of this little book a very fair general notion of the main features of bird-life. Considerable discrimination is shown in the selection of material, the author having chosen good subjects, and interesting and, for the most part, well-established facts. Moreover, Mr. Pycraft writes in a simple and attractive way, so that the book is very readable and interesting, and contains a deal of instruction in an unobtrusive form.

"IN BIRD-LAND WITH FIELD-GLASS AND CAMERA." By Oliver G. Pike. (Fisher Unwin.) 6s. Illustrated. This is a pleasant little book describing simple country sights within the province of all who have learnt to use their eyes. The author treats chiefly of birds, and his scenes and anecdotes are mostly derived from the country about the north of London, although a few chapters are devoted to the Norfolk Broads. Mr. Pike is an ardent bird photographer, and many of his photographs reproduced in the book are excellent. Some of them, however, are rather in the nature of puzzle pictures, and it is questionable if everyone will eventually find the bird. Photographs of wild birds or nests are certainly of little use for purposes of identification, but a method of showing at a glance the correct proportions would be a distinct gain. Turn, for instance, to the photographs on pages 245 and 265 of the present book. The one is of a sedge warbler's nest, the other of a nest of Montague's harrier, but who can tell by an examination of these photographs that the egg of the harrier is some two-and a-half times the size of that of the sedge warbler? On the other hand, in the beautiful photograph, forming the frontispiece to the volume, of a garden warbler on its nest, we get a very good idea of the relative size of the bird. This is evidently because some gooseberry leaves are shown in line with the bird, and everyone knows approximately the size of a gooseberry leaf, and so can gauge the size of the bird. But it is not often possible in a photograph from life to show side by side with the bird or egg so well known an object as a gooseberry leaf. However, with so many enthusiasts now working at bird photography, we do not despair of a solution to this difficulty of proportions. Mr. Pike's grammar is not always of the best, and his rather bald literary style denotes a young writer, but he leads us in the open, and evidently tells us exactly what he has seen himself; which, after all, is more valuable in a book of this character than flowing phrases and polished periods. The author was fortunate in finding in Norfolk a number of bearded tits to shoot at with his camera, and we are glad indeed to have this further evidence of the presence of this rare bird in the country. Ornithologists will also be interested in what Mr. Pike has to say about the habits of the moorhen.

BOOKS RECEIVED.

The Riddle of the Universe. By Ernst Haeckel. (Watts & Co.) 6s. net.

The Royal Observatory, Greenwich: Its History and Work. By E. Walter Maunder, F.R.A.S. (Religious Tract Society.) Illustrated. 5s.

The Bible Atlas. 6th Edition. By Major-General Sir C. W. Wilson. (S. P. C. K.) 10s. 6d.

Inorganic Chemistry. By Prof. Meldola. 5th Edition. (Murby.) 2s.

A German Commercial Reader. By S. E. Bally. (Methuen.) 2s.

Design in Nature's Story. By Walter Kidd. (Nisbet.) 3s. 6d.

Elements of Hydrostatics. By S. L. Loney, M.A. (Camb. Univ. Press.) 4s. 6d.

Religion and Life. By R. Russell. (Longmans.) 2s. 6d. net.

The Origin of Species. (Popular Edition). By Charles Darwin. (Murray.) 2s. 6d. net.

The Temples and Ritual of Asklepios. By Richard Caton. (Camb. Univ. Press.) 3s. net.

Astral Gravitation. By Wm. Leighton Jordan. (Longmans.) 9s.

Annals of the Lowell Observatory. Vol. II. (Camb. Univ. Press.)

The Reliquary and Illustrated Archæologist. Vol. for 1900. (Bemrose.) 12s. net.

Agricultural Zoology. By Dr. Ritzema Bos. (Methuen.) 3s. 6d.

Elements of Geology—Skertchly's. Revised by James Monckman. (Murby.) 1s. 6d.

Animated Picture Specialities. Catalogue. (Warwick Trading Co.)

Elements of Mineralogy. By F. Rutley. (Murby.) 2s.

One Thousand Objects for the Microscope. By M. C. Cooke. (Warne.) Illustrated. 2s. 6d.

An Ingenious Method of French Conjugations. Parts I., II., III. By Leopold Courtial. (Firth College, Sheffield.) 1s. 6d. each.

Masterpiece Portfolios of Art. No. 3. (*Review of Reviews* Office.) 1s. 3d. post free.

THE PYGMIES OF THE GREAT FOREST.

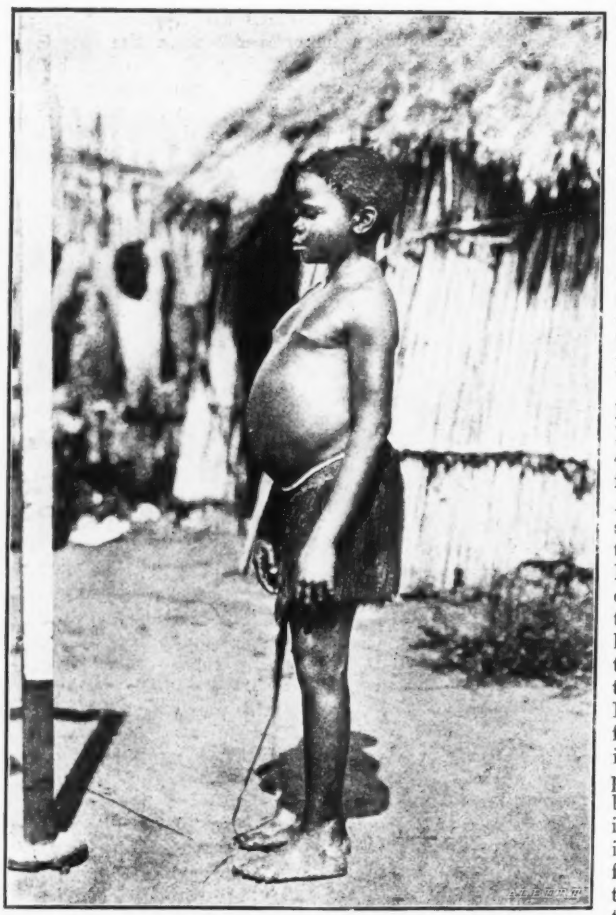
By R. LYDEKKER.

IN the preceding article of the present series the attention of the reader was directed to the dwarf black races of the tropical forests of Luzon and the coral shores of the Andamans. He has now to transport himself in imagination to the great forest of the Upper Congo and the watershed between the basin of that mighty river and the Nile in the Niam-Niam country. So vast is this forest, as we learn from the accounts of Sir H. M. Stanley and other explorers, that the traveller may march through it for weeks or even months without finding a break in the wilderness of stems, while so dense is the canopy of branches and leaves overhead that even at midday, when the sun is shining in its full strength above, the light is toned down to a grey gloom, and the shades of night fall long before the sun has touched the horizon. In this perpetual gloom live the Pygmies, the most diminutive of the human inhabitants of the globe, of whose existence there have been more or less authentic rumours since the time of Herodotus and Aristotle, but whose true characteristics and mode of life it has been reserved for recent times to disclose. To the ancient Egyptians the Pygmies were well known, under the name of Danga, and there are definite records of individuals being from time to time brought from the region of the White Nile to the court of the Pharaohs as captives, where they were depicted in the frescoes under the name of Akka. The accounts given by the ancient classical writers of these diminutive people, which were not improbably derived from the Egyptian captives, are, however, so vague and so mingled with the fabulous that they are of little or no value to the anthropologist. But in the early part of the seventeenth century the English sailor, Andrew Battell, who had been in captivity among the Portuguese from 1589 to 1607, gave an excellent although brief account of the Pygmies, whom he calls Matimbas, and compares in point of size to European children of twelve. He speaks of them as fleeing from contact with the Negroes of Loango, and slaying with their bows and arrows (which were carried by both sexes) the great apes called Pongo; the latter term being, by the way, the proper name of the species we now designate gorilla. Again, in 1686, the Dutch writer Dapper speaks of the dwarfs of the same district under the names of Mimos and Bakke-bakke; but from that date nothing seems to have been heard of these people till the sixties and seventies of the present century.

In 1861 Dr. Touchard records the destruction of a tribe of dwarfs, whom he calls Akoa, in the interior of the Gabun; and states that an adult who had been captured measured only 4½ feet in height, and had a comparatively short and rounded head. Yet another tribe inhabiting the interior of the Gabun, known as the M'Boulous, were described about the same date, and stated to be not more than three thousand in number. Somewhat later the Baboukos, or Pygmies of Chinchoxo, were described by a German writer, who comments on their relatively large and rounded heads and small stature; a man supposed to be about forty years of age measuring rather less than 4 feet 6 inches. Paul du Chaillu likewise encountered Pygmy Negroes in Ashangoland, and saw one man of the stature just mentioned, although he gives the average height of the women at 4 feet 8 inches.

In still more modern times, when the interior of the Dark Continent was being gradually opened up, Stanley heard of Pygmies, whom he calls Watwas, in the country within the great bend of the Congo, who hunted the lordly elephant to death with poisoned arrows, and whom he describes as of a chocolate-brown colour. And a Dr. Wolff refers to the members of the same or an allied tribe as never exceeding 4 feet 7 inches, and averaging four inches less in height. But to the celebrated German traveller, Dr. Schweinfurth, was reserved the honour of first making known to European science the Akkas of the ancient Egyptians, whom he first met with at the court of the ruler of Mambettu (Monbuttu), but whose home is on the Aruwimi, a tributary of the Upper Congo in about lat. 3° N. and long. 25° E. As we learn from Major Casati's "Ten Years in Equatoria," the author of which accompanied Stanley in his famous expedition to relieve Emin Pasha, the name Akka means pigmy or dwarf; being also applied by the natives of the Aruwimi country to a breed of diminutive fowls. By themselves the Akka are called Efè. Akka is their Mambettu name, while in Sandeh they are termed Tiki-tiki. The latter name, according to the traveller last mentioned, is, however, occasionally heard in Mambettu, and is not, as has been supposed, synonomous with Akka. Properly speaking, says Major Casati, Akka is applicable to one very small active race, whose skin is of a reddish brown colour and thickly covered with hair, while Tiki-tiki denotes a taller and stouter-built race, with a darker and less hairy skin, who frequent the more open mountainous regions. The two are said to be unfriendly and frequently at war with each other. The Akkas seen by Dr. Schweinfurth were in the military service of the ruler of Mambettu; one of them, who unfortunately died at the end of the journey down country, was procured for the purpose of being taken to Europe. More fortunate in this respect was the Italian traveller Miani, who, although himself falling

a victim to the climate and the hardships of travel, was the means of procuring two Akkas, who arrived safely, first at Cairo, and subsequently in Italy; one of them dying at Verona in the winter of 1883. An Akka girl was also brought by another Italian traveller to Trieste. Later Emin Pasha transmitted to the Natural History Branch of the British Museum the skeletons of a male and female Akka; the latter, which Major Casati says was obtained by himself and presented to Emin, being nearly complete, and now mounted in the exhibition series. Making due allowance for a few missing vertebræ, and likewise for the soft tissues, this



An Akka Woman. (From Major Casati's "Ten Years in Equatoria." Warne & Co.)

skeleton, in the opinion of the late Sir W. H. Flower, indicates a woman of exactly four feet in height, who was evidently fully adult. Emin states, however, that a living woman whom he measured barely reached 3 feet 10 inches; being therefore greatly inferior in point of size both to the Pygmies of Asia and also to the Bushmen of South Africa. Nevertheless, as may be seen in the aforesaid skeleton, and also in the numerous portraits of these little people which have been published of late years, the Negrillos (as the African Pygmies are technically called) are in all respects well formed and well proportioned.

Descriptions of the Akkas and other tribes of Pygmies have also been published by Major Casati, as well as by several other later African travellers; and we now possess a very large amount of information not only with regard to their physical characteristics and their mode of life, but also in respect to their geographical distribution. It is now ascertained, for instance, that the range of these dwarfs originally extended from near the Atlantic sea-board in the Gabun district as far eastwards as the confines of Lake Tanganyika; and from N. latitude 3° on the Aruwimi river to about latitude 7° in the neighbourhood of Lakes Stephanie and Rudolf, where they were recently encountered by the American traveller Dr. Donaldson Smith. In the Lake Rudolf district, where they are known by the name of Dume, these people depart, however, so widely from the diminutive stature of the Akkas of the Aruwimi that they can scarcely be called Pygmies at all in the literal sense of that term; Dr. Donaldson Smith giving their average height as about 4 feet 11 inches. Nevertheless, as this tribe seems to agree with the more typical Pygmies in general physical character, its members must be included among the Negrillos. Not improbably their superior stature may be attributed to climatic influences, and perhaps also in some degree to crossing with the Negro tribes among whom they dwell. That such crossings do take place seems to be evidenced by certain tribes living on the upper Ituri, who are believed to trace their origin to inter-breeding between pure-blooded Negrillos on the one hand and Bantu or other negroes on the other.

Exclusive of these aberrant frontier tribes, Sir William Flower estimated the average height of the African Pygmies at about 4 feet 7 inches for the men, and 4 feet 3 inches for the women; this estimate according fairly well with that of Major Casati, who says that most Akkas do not exceed 4½ feet. As has been already stated, in the rounded and broad form of their heads, these people differ markedly from the long-headed Negroes among whom they dwell; although this character is not so pronounced as was at first considered to be the case by some observers. Chocolate-brown has been mentioned above as the colour of the skin of the Pygmies, and it has been compared to ordinary tablet chocolate or to slightly roasted coffee-berries. In this respect, therefore, these people differ markedly from their southern cousins the Bushmen, in which it is leather-yellow. Moreover these people lack the prominent cheek-bones and lozenge-shaped face of the last-mentioned race; while the women seldom exhibit in any marked degree a peculiarity of figure characteristic of the "Hottentot Venus" and other Bushmen females. Then, again, although the scalp-hair in all these African races is of the frizzly, or mis-called woolly, type, that of a Pygmy does not grow in tufts like the black locks of a Bushman, but is described as being of a more fleece-like character, and is frequently of a more or less light shade of brown. But the most remarkable capillary peculiarity of the Akkas is the presence of a fine down over the whole skin; Emin Pasha stating that in the individuals examined by him this took the form of thick, stiff hair, almost like felt; this hair, according to the observations of Major Casati already referred to, being more developed in the typical Akkas than in the Tiki-tiki. Adult men have a certain amount of hair on the cheeks and chin. In connection with the down on the body, it may be mentioned that a very similar hairy covering is found on the children of the higher races of mankind some time previous to birth. As regards their general cast of features, Akkas display a somewhat ultra development of the ordinary Negro

type, this being specially marked in the projection of the jaws, the eversion of the lips, and the width and flatness of the nose. In a convexity of the profile below the nose Akkas display a character often met with among Bushmen.

From the various accounts that have been given of their mode of life, it appears that Akkas, like other African races of Pygmies, live chiefly by the chase, using bows, arrows, and lances with great dexterity, and slaying such large animals as elephants, buffaloes, and chimpanzees with comparative ease. On account of this dexterity in the use of weapons, as well as from their skill in hunting, their great bodily activity, and their personal courage, they are much esteemed as soldiers by the Negro tribes among whom they dwell, and whom they frequently serve as mercenaries. In other respects they appear, however, to avoid their neighbours, living in communities by themselves in tribal divisions, each of which has its own chief or king. No protection against cold being necessary in the tropical climate of equatorial Africa, most of them go about completely naked, those men who wear any covering at all being generally content with a piece of beaten bark suspended round the waist, while the women have only two or three leaves. No ornaments of any kind are worn by the former, while the latter do not pierce their ears. Although they are superior to the Australians in being acquainted with the mode of obtaining fire, yet they are by no means skilful in this operation, and they are accordingly in the habit of keeping trunks of fallen timber smouldering in certain suitable situations to which the members of the tribe can repair when they require a light. Each family manages its own affairs, and wives are purchased from their fathers for the consideration of a certain number of arrows. Unlike Negroes, these people are entirely free from superstitions of every kind, so that there are no witch doctors nor sorcerers among them; even the widely spread dread of the "evil eye" being, according to Major Casati, unknown among them. Judging from the circumstance that they bury their dead on the spot where they expire, without any ceremony and with no monument, it would seem, too, that they have little if any conception of a future existence or of a divine ruler of the world.

Many of the Akkas live entirely without shelter, save such as is afforded by the forest thickets or the overhanging banks of streams. Others, however, erect hemispherical huts, thatched with broad leaves, and having a diameter of about $6\frac{1}{2}$, with a height in the centre of somewhat less than 5 feet. Generally these primitive erections are scattered about at random in the forest or on the hills, although in rare instances they are aggregated into villages. These people are in the habit of exchanging the products of the chase with their Negro neighbours for arrows and lances, but use no other implements, a sharp arrow fulfilling the purpose of a knife; they possess no vessels of any description, drinking water from the streams in the hollow of the hand. Although they will eat almost any animal substance, inclusive of locusts and white ants, they have the saving virtue that they are not cannibals; and they never use salt. Neither do they keep poultry or other domesticated animals; and the arts of agriculture and horticulture are unknown among them. After a successful hunt, they are stated by Major Casati (from whose account we are largely quoting) to visit the banana plantations of their neighbours, where for every bunch of fruit that they sell a piece of meat is substituted. When, however, they have nothing to offer by way of exchange, they are not above acquiring a bunch of bananas by the simple expedient of stealing it; and they not unfrequently make raids upon their taller but less warlike neighbours for the purpose of carrying off these and such other vegetable products as they can lay hands upon. They are, indeed, passionately fond of vegetable food, of which they will devour almost incredible quantities when opportunity occurs, being at all times endowed with a marvellous capacity for food.

In addition to their bows, arrows, and small lances, in the use of which they display remarkable skill, the Akkas carry small shields, of about 20 inches in length by 12 in width, which they manufacture themselves by plaiting strips of bark. In elephant and buffalo hunting they resort to the cruel method of first blinding the unfortunate animal with arrows and then harrying it to death with their lances. The use of nooses and nets, either on land or in the water is quite unknown among these primitive little people, who are likewise unacquainted with angling. Consequently, their only method of capturing fish is by damming off some portion of a stream or pool, and then laboriously baling out the water until its denizens are left in the mud.

Turning to the consideration of the affinities of the Akkas and their kin, we are confronted with a problem of great difficulty, and one to which our present means of information do not admit of giving a decisive solution. It has been suggested by a Swiss anthropologist that certain prehistoric human remains discovered at Schaffhausen indicate the occurrence of Negrillo Pygmies in Europe; but this hypothesis, to say the least, seems to stand in need of confirmation. Putting this aside, almost the only safe statement that can be made is that Negrillos form a branch of the great Negroid stock. Before their characteristics were as well known as at present (and there is still room for much advance in this respect) they were considered to be near allies of the Bushmen; but, as Dr. Deniker well observes, there is little or no foundation for this idea, as there are few features common to the two races, while the dissimilarities are many and strongly marked. Neither have we any decisive evidence of a close relationship between the Pygmies of Asia on the one hand and those of Africa on the other, although both are included by Mr. A. H. Keane under the title of Negrito.

But the whole question of the origin and relationships of the Negroid stock is still involved in such a maze of confusion and uncertainty that it is very difficult to find even a single firm starting point upon which to base further inductions. According, however, to the best of authorities, it seems probable that the Bushmen indicate the most primitive and generalised representatives of this stock with which we are acquainted. And if this be so, it follows that the black skin of the true Negroes and of the Pygmies is an acquired and not a primitive feature; support to this theory being afforded by the fact that Negro infants are much lighter coloured than their parents. Possibly then, both Bantu Negroes and the Akka Pygmies are diverging branches from a stock related to the modern Bushmen. But whether we are to look upon the Asiatic Pygmies as more closely allied to the Akkas than to any other Negro races may for the present be left an open question.

It may be added that if the light-coloured Bushmen be really the most primitive type of the Negroid stock, a death blow is delivered to the theory of a specially near relationship between the latter and the black-skinned Anthropoid Apes of Equatorial Africa.

XUM

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

It frequently happens that the objects for which the microscopist is searching are mixed with coarser materials, from which it is necessary to separate them. As a rule judicious washing will effect the purpose, but sometimes it is necessary to resort to burning or to the action of chemical reagents. Guano and various organic matters are cases in point which yield interesting residues after everything soluble has been washed away, and everything combustible has been burnt either with fire or with nitric acid. The siliceous cuticles of plants, too, may be procured by destroying all the other parts by chemical means. An effective way is to heat the specimens in nitric acid, and add slowly and very cautiously a small quantity of powdered chlorate of potash. This operation needs great care, and the face and hands should be protected from the spluttering of the boiling acid.

Considerable confusion exists as to the proper nomenclature of photography with the microscope. In Germany and France the term micro-photography is very common, while in English photo-micrography and micro-photography mean very different things. Thus: a *photo-micrograph* is a photograph of a small or microscopic object, usually made with a microscope and of sufficient size for observation with the unaided eye; while a *micro-photograph* is a small or microscopic photograph of an object, usually a large object, like a man or a building, and is designed to be looked at with a microscope.

Collodion stained with aurantia makes a useful colour screen. Dr. Leaming, when preparing the negatives for the plates of Wilson and Starr's atlases, made his colour screens by staining a lantern plate, from which all the silver salts had been removed, with an alcoholic solution of tropæolin, and then, after drying, Canada balsam and a cover-glass were applied.

When a carmine stain is to be used the results may be obtained quicker by heating the stain. Place the watch-glass containing the stain on a wire netting over the opening of a water bath. As the water boils the heat of the steam will cause the stain to penetrate more rapidly, with the result that the details of the specimen are brought out more sharply. These results may be obtained only with tissue which has been previously hardened. Those hardened in a solution of chromate of potash to which a few drops of chromic acid have been added give the best results.

Of the many mounting mediums miscible in water which are used by the microscopist the most generally useful is glycerine. It is necessary that it should be pure, and to be quite sure that all foreign matters such as dust particles are eliminated, it should be filtered through filter paper or absorbent cotton before being used. For preparing objects for final mounting, glycerine and water mixed in equal quantities forms a good mixture. For many purposes the final mounting in glycerine is made in an acid medium, viz., glycerine 99 c.c., glacial acetic acid 1 c.c. By extreme care in mounting, and by occasionally adding a fresh coat to the sealing of the cover-glass, glycerine preparations last a long time. They are liable to be very disappointing, however. In mounting in glycerine care should be taken to avoid air-bubbles, as they are difficult to get rid of. A specimen need not be discarded, however, unless the air-bubbles are large and numerous.

We have pleasure in calling the attention of microscopical societies to the list of lectures which has been arranged for delivery by members of the Extension section of the Manchester Microscopical Society during the coming winter. The lectures and demonstrations treat of every phase of microscopy, and are given gratuitously to any society that may care to apply for them. Applications may be made to the Hon. Secretary, 56, Brookland Street, Eccles New Road, Manchester.

Ink for writing on glass may be prepared by dissolving 20 grains of brown shellac in 150 c.c. of alcohol in the cold, then adding, a drop at a time, a solution consisting of 35 grains of borax dissolved in 250 c.c. of distilled water. If this precipitates the shellac add more alcohol, allowing the excess to evaporate afterwards, or warm the solution until the precipitate disappears. One gramme of methylene blue may be used to colour the ink.

The following easy and efficient method of preparing nucleated blood for class use has been adopted in the histological laboratory at Cornell University. A few drops of the fresh blood of a necturus are put in a solution of osmic acid (1 per cent.) and allowed to stand for fifteen minutes. The corpuscles by this time are fixed and have settled to the bottom, and the fixer can now be decanted off. After washing in water the blood is carried on through the various grades of alcohol, stained with paracarmine, dehydrated, cleared, and, as a final step, Canada balsam is added sufficient to procure the proper dilution of the corpuscles. A drop of the balsam is then put on a slide, covered with a cover-glass, and is then ready for use.

Mr. E. L. Fullmer, of Ohio State University, has had considerable experience in mounting small Coleoptera and other small insects, and in the pages of the *Journal of Applied Microscopy* he briefly describes the more successful of his methods. That which gives the best results for general work is as follows: drop the specimens into absolute alcohol, and leave for an hour or more to dehydrate, transfer to xylol for a few minutes to clear, and mount in balsam. To make opaque objects transparent, boil in caustic potash for a moment, and then treat as above described. In working with scale insects, the insects are first picked out of the scales and placed upon a slide where it is desired to mount them. A few drops of a five per cent. solution of caustic potash are applied, and the specimens boiled in this for two or three minutes by holding them over a bunsen flame, after which proceed as above.

[*All communications in reference to this Column should be addressed to Mr. J. H. Cooke at the Office of* KNOWLEDGE.]

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

BORRELLY-BROOKS'S COMET.—This comet is now exceedingly faint, the brightness on November 1st being only 03, as compared with 1 at the time of discovery. Its position is 6 degrees east of α Draconis at the beginning of November, and the comet is travelling very slowly in an easterly direction.

PERIODICAL COMETS.—Barnard's Comet (1884 II.) and De Vico-E. Swift's Comet (1844-1894) are possibly visible in very powerful telescopes, but the conditions are not favourable. No announcement has been made at the time of writing that either of these objects has been redetected in the large instruments which are doubtless being employed for the purpose. Amateurs provided with ordinary telescopes must wait for future returns when these comets will be better presented. In *Ast. Nach.*, 3664, Mr. F. H. Seares gives a continuation of his finding ephemeris for De Vico-Swift's Comet, and from this we extract the following:—

Date.	R.A. H. M. S.	Dec. ° ′	Distance in Millions of Miles.
November 16 ...	18 44 57 ...	25 48 S. ...	224
,, 28 ...	19 16 12 ...	24 54 S. ...	227
December 14 ...	19 59 39 ...	23 2 S. ...	231

The perihelion passage will take place on February 13th, 1901, but the comet will be too near the sun for it to be observed.

FIREBALL OF SEPTEMBER 2, 6H. 54M.— About 35 accounts of this brilliant object were received, but they were not very definite as regards the particulars of the phenomenon. Some of the descriptions have, however, afforded a satisfactory means of comparison. Adopting the ζ Cepheid radiant at 334° + 57° as best representing the observations, it appears that the meteor became visible at a height of 85 miles over Richmond, Yorks., and ended at a height of 20 miles over a point near Fleetwood, Lancashire. Its length of observed course was 84 miles. It was certainly one of the largest and most brilliant meteors seen during the year. Its sun-lit streak remained visible for more than half-an-hour, and formed one of the most striking features of the event. It is remarkable to find that the discordances among the various observers are very great in regard to many of the details. Three of the observers give the time as about 6 p.m., while another mentions 6.15 p.m. Five others give the following times, 7h. 0m., 7h. 15m., 7h. 20m., 7h. 30m., 7h. 30m. Yet it is certain from the rough descriptions of the path that only one meteor was observed and that the correct time was as nearly as possible 6h. 54m. With regard to the streak or train left in the meteor's wake, several correspondents say there was none whatever visible. Three state that there was a tail which remained in sight about 5 minutes, several give the time of its duration as 10 minutes, two others watched it for 30 minutes, while at Wetherby it remained in view until 7h. 30m., or 36 minutes after the meteor flashed across the sky. Some of the observers were

much struck with the apparent proximity of the fireball and thought that it must have fallen within two or three hundred yards of the spot where they stood. People in Yorkshire, Lancashire, Scotland, and Wiltshire were similarly impressed. In Wiltshire, a party of observers thought the fireball must have alighted in a field about a mile off, while at St. Andrews, Scotland, it seemed to fall into a field of turnips close to the observers. The descriptions vary so much as regards the time and position of the object that several large fireballs would, on first consideration, appear to have appeared on the evening in question. There is no doubt, however, that there was really only one, but that some of the accounts are inexact, and this we might naturally expect, as most of the observers were inexperienced and must have been taken by surprise at the suddenness and brilliancy of the apparition.

FIREBALL OF SEPTEMBER 16, 8H. 44M.—A fine meteor, brighter than Venus, was seen at this time by Mr. W. E. Besley, of London, Mr. J. Gilbert Wiblin, of Oxford, Mr. Chas. Parker, of Handsworth, near Birmingham, and Mr. T. Harries, of Llanelly. The observations are in satisfactory accordance, and show that the radiant was in 324°−25° between Capricornus and Piscis Australis. The meteor fell from a height of about 50 miles above Bewdley, to 32 miles above Wigan, and had a visible path, as observed, of about 86 miles. But it is probable that the real length of path was greater than this, for the observers did not see the meteor until it had traversed a section of its course.

OBSERVATIONS OF SHOOTING STARS IN SEPTEMBER. — The month was highly favourable for astronomical observations. At Bristol, 127 meteors were seen during 17 hours of watching distributed over 10 nights. Both at the opening and closing of the month there were active radiants at 333°+56°, 71°+65°, and 47°+43°. During the last week in September showers were seen from 6°+11°, 23°+57°, 27°+3°, and 76°+32°.

THE NOVEMBER METEORS (LEONIDS).—Observers should look out on the mornings of the 14th, 15th, and 16th, as it is quite possible, notwithstanding the failures in preceding years, that a fine display may be presented. We are not yet sufficiently acquainted with the stream in its past vicissitudes, or present and future developments, to speak positively as to whether the shower will or will not return in great brilliancy this year. Nor is it possible to say exactly when or where the display will be visible to the best advantage should it return. But the morning hours of November 15 appear to be the most promising, and will be likely to furnish a rich shower, if not a really grand display, though the moon will be visible in the same region of the sky as the radiant point. She will, however, be in her last quarter, and ought not to seriously interfere with successful observation.

THE FACE OF THE SKY FOR NOVEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the 1st the sun rises at 6.55 and sets at 4.33; on the 30th he rises at 7.44 and sets at 3.54. There will be an annular eclipse on the 22nd, invisible at Greenwich, the line of central eclipse passing across South Africa, the Southern Indian Ocean, and Western Australia. At the Cape of Good Hope, a partial eclipse, magnitude 0.492, will be visible, and at Natal a partial eclipse of magnitude 0.717.

Sunspots are not likely to be either large or numerous.

THE MOON.—The moon will be full on the 6th at 11.0 P.M., will enter last quarter on the 14th at 2.38 A.M., will be new on the 22nd at 7.17 A.M., and will enter first quarter on the 29th at 5.35 P.M. The principal occultations visible at Greenwich are as follows:—

Date.	Name.	Magnitude.	Disappearance.	Angle from North.	Angle from Vertex.	Reappearance.	Angle from North.	Angle from Vertex.	Moon's Age.
				°	°		°	°	d. h.
Nov. 6	π Arietis	5·6	9.54 P.M.	49	75	10.58	274	286	14 9
,, 12	A^1 Cancri	5·6	11.54 P.M.	100	139	12.58	289	328	20 11
,, 30	κ Piscium	5·0	6.11 P.M.	21	28	7.7	281	277	8 12
,, 30	16 Piscium	5·6	11.23 P.M.	96	59	12.14	220	181	8 17

THE PLANETS.—Mercury will be in inferior conjunction with the Sun on the 20th, and will be a morning star throughout the remainder of the month. He is, however, not very favourably situated for observation in our latitudes.

Venus is a morning star, rising shortly before 3 A.M. at the beginning of the month, and about 4.15 A.M. at the end. On the 15th, three-quarters of the disk will be illuminated. The path of the planet is from near β Virginis to κ Virginis, passing a point about 4° north of Spica on the 21st.

Eros traverses a retrograde path through the northern part of Perseus into Cassiopeiæ, and is visible throughout the night. The following ephemeris, for Berlin midnight, may be useful:—

	True Right Ascension.	True Declination.
	H. M. S.	° ′
November 1 ...	2 15 8 ...	+53 51 1
,, 6 ...	2 5 7 ...	54 17·5
,, 11 ...	1 54 51 ...	54 18·9
,, 16 ...	1 45 9 ...	53 54·5
,, 21 ...	1 36 54 ...	53 5·2
,, 26 ...	1 30 48 ...	51 53 7
December 1 ...	1 27 20 ...	50 23·8

At the beginning of the month this planet will be about equal to a star of magnitude 9·5.

Mars is becoming better situated for observation at convenient hours, rising on the 1st just before half-past eleven, and on the 30th shortly after half-past ten. The path of the planet is easterly through Leo, and on the 18th the planet will be $1\frac{1}{2}$ degrees north of Regulus. On the 15th, the illuminated portion of the disk will be 0·896, and the planet will be 125 millions of miles from the earth.

Jupiter is rapidly approaching conjunction with the Sun, and can only be observed under very favourable circumstances. On the 1st he sets about 6 P.M., and on the 15th at 5.23 P.M.

Saturn may still be observed for a short time in the early evening. During the month the planet traverses a short easterly path in Sagittarius, nearly between the stars λ and μ. On the 1st he sets at 7.24, and on the 30th at 5.40 P.M.

Uranus is too near the Sun to be observed.

Neptune, in Taurus, is visible throughout the greater part of the night, rising on the 1st shortly after 7 P.M., and on the 30th soon after 5 P.M. The path of the planet is a short westerly one, nearly midway between 132 Tauri and Eta Geminorum.

THE STARS.—About 9 P.M. at the middle of the month, Gemini will be low in the north-east; Auriga and Perseus high up in the east; Taurus between east and south-east, with Orion below; Aries nearly south-east; Cetus nearly south; Andromeda and Pisces in the south; Cassiopeia almost overhead; Pegasus and Aquarius towards the south-west; Cygnus and Aquila in the west; Lyra a little north of west; Corona setting in the north-west; and Ursa Major below the pole.

Minima of Algol occur at convenient times on the 1st at 9.11 P.M., on the 4th at 6.0 P.M., on the 21st at 10.53 P.M., and on the 24th at 7.42 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of October Problems.

(W. Geary.)

No. 1.

1. Kt to B5, and mates next move.

No. 2.

Key move—1. K to Ksq.

If 1. . . . B to B5, 2. Kt to Kt4.
1. . . . P to B3, 2. Q to Q8ch.
1. . . . P to K6, 2. Q to B6ch.
1. . . . Any other, 2. P to K3.

[This problem has been much and deservedly admired.]

CORRECT SOLUTIONS of both problems received from W. de P. Crousaz, H. S. Brandreth, Alpha, G. A. Forde (Capt.), H. Le Jeune.

Of No. 1 only from J. T. W. Claridge, H. Boyes, Major Nangle.

H. Boyes.—In reply to 1. K to B2, Black has a valid defence in 1 . . . B to B5. If then 2. P to K3, B to Kt4; or if 2. Kt to Kt4, P to K6ch. It is a very good "try."

P. A. Cobbold (Ontario).—Your solutions of the September problems are quite correct. Yes, most experienced solvers make use of the diagram only, at any rate for two movers. When White has a choice of moves at any stage after the first move the result is a dual, *e.g.*, in the September problem (No. 2), after 1. P to Kt5, Kt (K8) moves, there would be dual mates in answer to four different moves of the Knight if the Black Rook at R8 were removed. That is, there would be four duals. A dual on the *first* move is generally known as a "cook," and of course ruins the problem.

Major Nangle.—See reply to H. Boyes. Many thanks for the problem, which shall be examined and published if sound.

J. J. Allen.—Problem received with thanks. You are perfectly correct with regard to Mr. Gundry's problem in the June number. How the flaw came to be overlooked is difficult to say.

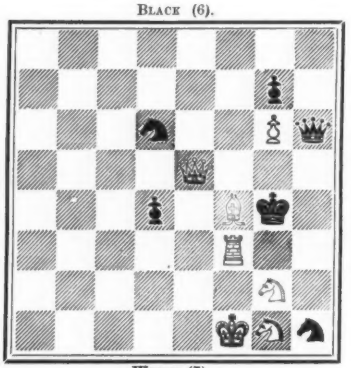
After an interval of three or four months, it has remained for Mr. J. J. Allen, of Calcutta, to point out a flaw in Mr. W. H. Gundry's problem, published in the June number. In reply to 1. KtKt3, Black can play Q to QKt3ch, and there is no mate. It is very strange that this should have escaped the notice of not only the composer, but the band of regular solvers, to say nothing of the Chess editor. As Mr. Allen suggests, the problem may be rendered sound by placing the White King at Kt2 instead of Ktsq.

PROBLEMS.

By P. G. L. F.

No. 1.

BLACK (6).

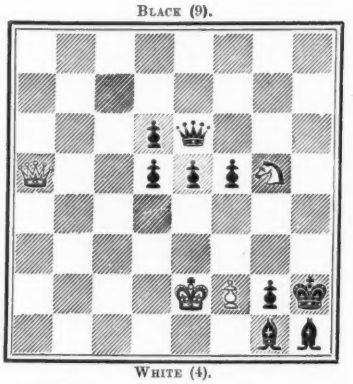


WHITE (7).

White mates in two moves.

No. 2.

BLACK (9).



WHITE (4).

White mates in three moves.

CHESS INTELLIGENCE.

I omitted to state last month the result of the tie for the first three prizes in the Munich Tournament. Maroczy, after losing one game, retired owing to ill-health, and had to be content with the third prize. This left Pillsbury and Schlechter equal first and second, and the tie-match between them resulted in a win for each, and two games drawn. They accordingly divided the first and second prizes. This is certainly Herr Schlechter's finest performance in tournament play. He seems to have overcome to a great extent the tendency to draw, which at one time earned him the well-known title of the "drawing master," a title which, by the way, was originally held by his fellow-townsman, Herr Englisch.

A copy of the third edition of Mr. James Mason's "Principles of Chess" (Horace Cox) has been sent for review. The merits of the book, and the greater portion of its contents, are, or ought to be, so well known that little more than the fact of the appearance of this the latest edition need be mentioned. It has been revised and enlarged to the extent of 327 pages. The appendix contains some interesting exercises on stalemate, the fifty-moves rule, and a scheme for calculating the value of drawn games in tournaments. Mr. Mason's plan is well known to readers of the *British Chess Magazine*. It is based on the principle that won games should count 1, drawn games 0, and lost games $-\frac{1}{2}$. This would to a great extent abolish the nuisance of the "accommodation" draw, for a drawn game would approach in value nearer to that of a lost game than that of a game won. Mr. Mason has advocated this reform for the past seven years, so far without success. The book retains its former excellent binding, and still costs only half-a-crown. Evidently it will never become out of date.

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